Pluto - Not A Planet?

Destroying the IAU definition of a planet, reasons why, and more!

A presentation
by Jack Mitch Culberson

Creator's Note

I am just a boy that loves to make stories, write songs, compose songs, animate films, and make some art! Talking and enthusiasm about space is just a hobby of mine. Please note I'm not a qualified planetary scientist, and the statements I put on those of some planetary scientists say are just my opinions.

Introduction

When Pluto was discovered in 1930, it was the smallest, most distant planet, until in the 1990s, small, Pluto-like planets were found, causing a commotion.

Astronomer Mike Brown discovered yet another small, icy planet called Eris in 2005. Was it considered the tenth planet? This has caused a debate on whether Pluto should be a planet or not. In August 2006, they decided to “demote” Pluto to a dwarf planet, which by their definition is “not a planet.” The debate still has not ended, and we don’t know when will it end. This decision made planetary science sound like politics!

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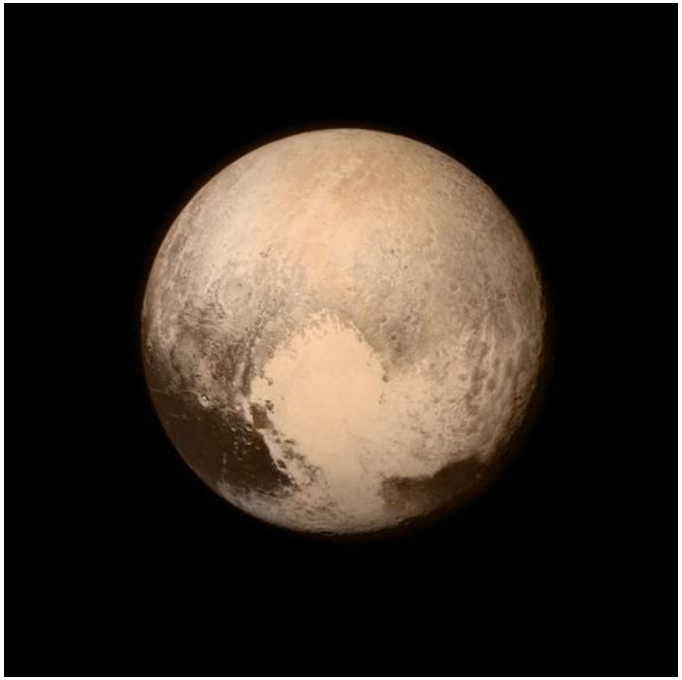
What is Pluto?

Pluto, discovered in February 18, 1930 by American astronomer Clyde Tombaugh, is the ninth largest planet orbiting the Sun. In fact, it's usually the furthest of nine of the largest planets orbiting the Sun and the smallest of them, as well! Pluto belongs to a class of tiny planets known as *dwarf planets*.

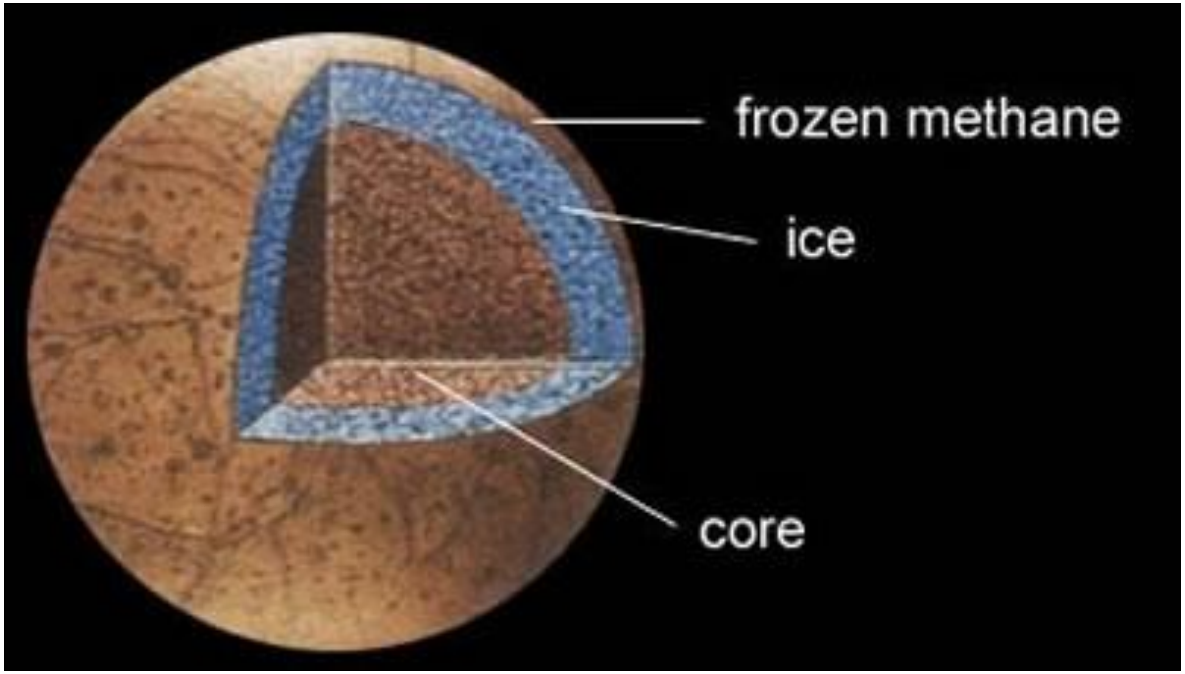


It has an atmosphere made of methane, nitrogen, and carbon monoxide. It is one of the coldest places in the Solar System (-375 to -400 ° Fahrenheit), and has five moons! Charon being the largest moon, and the others being Hydra, Nix, Kerberos, and Styx. In fact, Charon is not much smaller than Pluto!

Some fun facts about Pluto:

1. Pluto and Charon are a double planet! They orbit at a common point in space known as a barycentre. Because Charon is only half Pluto's size, it is considered a binary companion. This makes Pluto and Charon a binary system! They spin at the same speed!
2. No one knew what Pluto looked like until 2015. It was once thought to be a dead, frozen world until the New Horizons visited it in July 14, 2015!
3. Pluto has very few craters, indicating that the icy surface is geologically young! Its most remarkable feature is its heart-shaped region, known as the Tombaugh Regio, and that region does not have any craters!
4. Pluto's atmosphere sinks down when the planet goes further from the Sun. When Pluto comes at its closest, the atmosphere thickens!
5. The tiny planet got its name thanks to an 11-year old girl named Venetia Burney after its discovery. It was named after the Roman god of the underworld! Isn't that fitting for such a cold planet?
6. Pluto is an oddball as well! It's just like Uranus because it is tilted on its side. And like Venus and Uranus, it rotates backwards!
7. Pluto becomes the eighth-furthest of the nine largest planets orbiting the Sun when it crosses the orbit of Neptune! Pluto actually crossed Neptune's orbit on February 7, 1979, and did it again on February 11, 1999. It is thought that it was once an escaped moon of Neptune. Although their orbits cross, it is very unlikely that they will both collide.
8. Pluto has a diameter of 2370 kilometres. In fact, it is smaller than the Earth's moon!

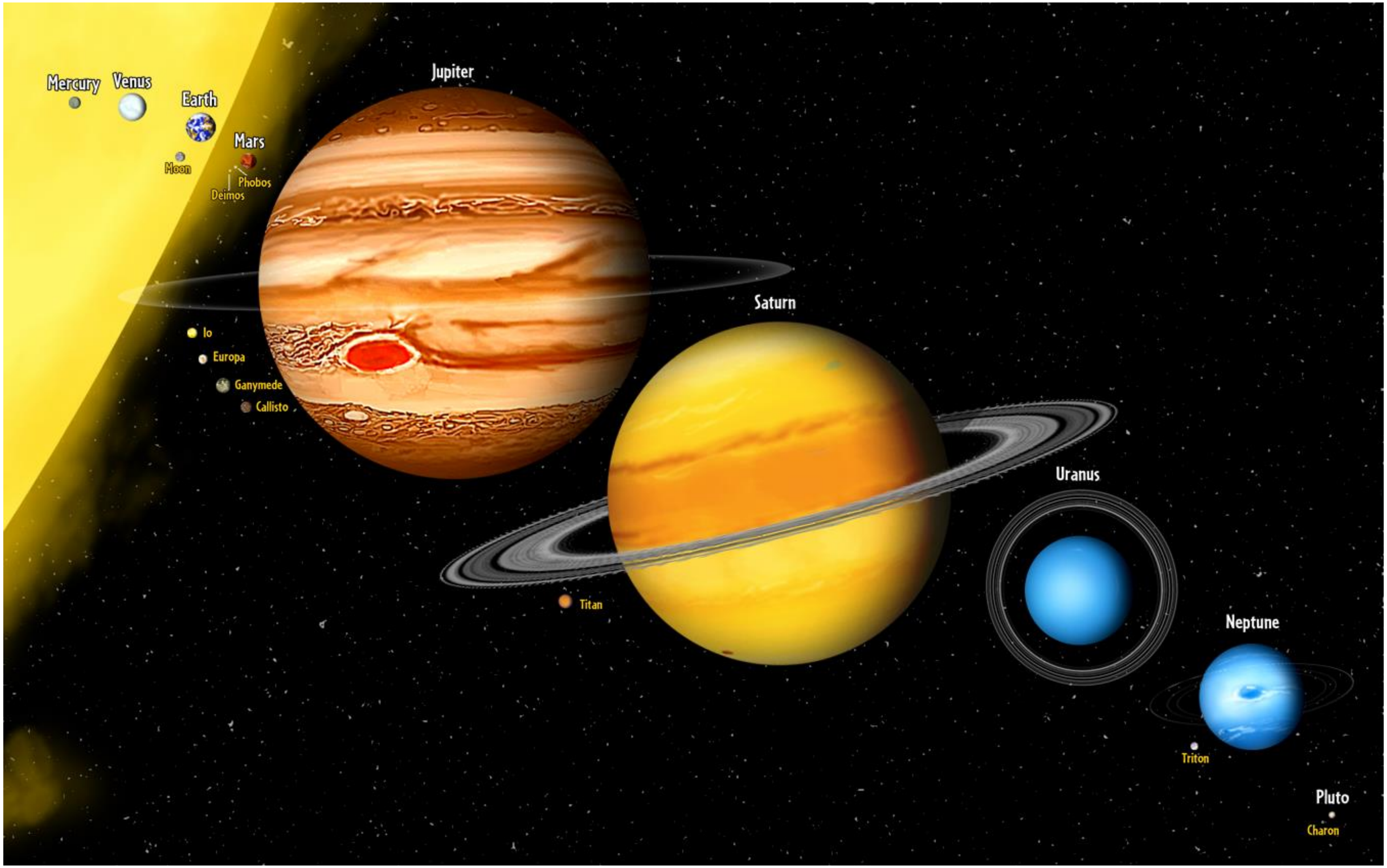
What's inside Pluto?



Pluto's surface is made up of ice. The core of Pluto is probably made of rock!

Pluto may also possess an ocean of liquid water under its icy shell. Could it be because of radioactive elements in Pluto's core? Would that ocean support life? Pluto has some interesting geology.

Nine Largest Planets



Compare Pluto's size to the eight other planets and the some of the largest moons in this picture. I created this image by myself.

The IAU's Planet Definition (IPD)

As more worlds similar to Pluto have been discovered, the IAU felt like it had to change the definition of a planet.

According to the International Astronomical Union (IAU), a planet must:
1. orbit around the Sun
2. have enough mass to be round
3. have cleared the neighbourhood in its orbit

According to this definition, Pluto *failed to meet the third criteria*. Does that mean Pluto is not a planet anymore? Well the simple answer is, not exactly. The truth is, the IAU no longer considers Pluto a planet, but that doesn't mean Pluto is no longer a planet! Here is their definition of a dwarf planet...

According to the International Astronomical Union (IAU), a dwarf planet must:

1. orbit around the Sun
2. have enough mass to be round
3. have not cleared the neighbourhood in its orbit

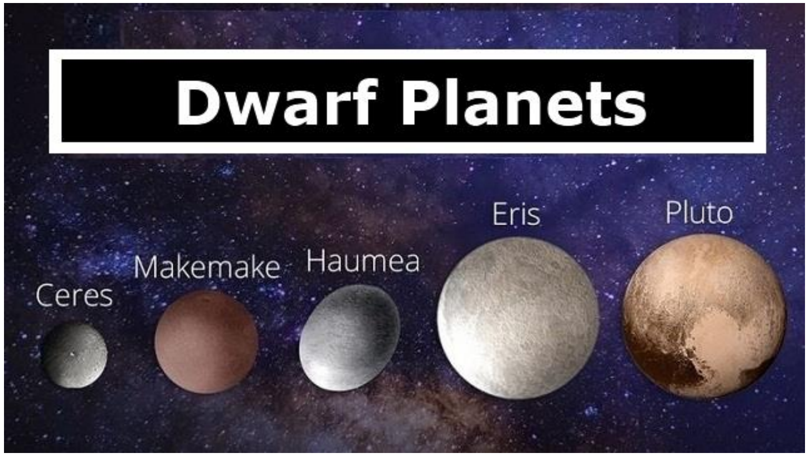
So what is a dwarf planet if it's not a planet? This, to me, seems quite silly. Dwarf stars are a category of star, so what are dwarf planets if they are not a category of planets?

Back then, when I was 11 years old, I had some trolls on YouTube saying; "Pluto is not a planet, you dumbass," and "Pluto will never be a planet again!" Sometimes those trolls started to call me names and cuss at me. I used to agree that Pluto is not a planet, but as I watched Alan Stern at a stream from the Lowell Observatory, well... to the IAU, I know you are good at naming objects in the Solar System, but I'm sorry, I can't use your definition of a planet anymore.

Is Pluto being treated unfairly as well as the other similar Kuiper Belt Objects near it?

Why Does The IAU No Longer Consider Pluto A Planet?

According to Mike Brown, one of the discoverers of the dwarf planet Eris, he said Pluto does not “dominate its orbit” as it shares Neptune’s orbit and those of other dwarf planets, and the eight other largest planets have “dominated their orbit” just because there are no other worlds orbiting near them. But can those planets really dominate their orbits if they were placed in Pluto’s orbit?



Pluto is in fact, the largest of all the dwarf planets. All of these tiny planets except Ceres orbit at the Kuiper Belt.

Another reason why the IAU no longer considers it a planet is because they are overacting and confused that they would find worlds similar to Pluto and Eris. According to Alan Stern, the purpose of the IAU in creating this definition was to limit the number of planets. Those are probably some of the reasons!

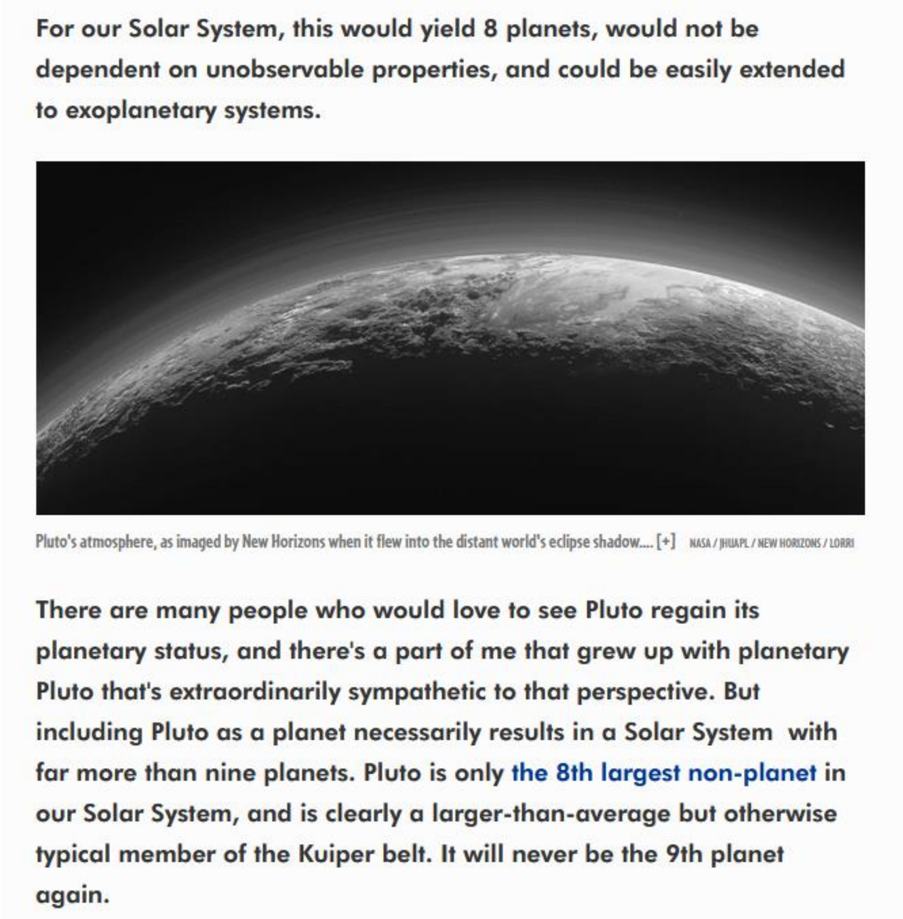
Members of the IAU, as seen in this picture, vote in the resolution on the planet definition.

In August 24, 2006, they decided to "demote" Pluto to a dwarf planet, which is "not a planet." Because of this, the mainstream media does not consider Pluto to be a planet anymore. The IAU members voted in the resolution whether Pluto should be a planet or not. This makes science sound like politics!

Even after this resolution ended, the controversy has not yet. Many planetary scientists disagree on the IAU's planet definition. In my opinion, because of this, the IAU has destroyed its reputation.

Some people said "Pluto will never be the ninth planet again, but that's not necessarily a bad thing." Look at this screenshot and go to the link here:

Source: https://www.forbes.com/sites/startswithabang/2019/07/09/this-is-everything-thats-wrong-with-our-definition-of-planet/?sh=762775042a6c



For our Solar System, this would yield 8 planets, would not be dependent on unobservable properties, and could be easily extended to exoplanetary systems.

Pluto's atmosphere, as imaged by New Horizons when it flew into the distant world's eclipse shadow.... [+] NASA / JHUAPL / NEW HORIZONS / LORRI

There are many people who would love to see Pluto regain its planetary status, and there's a part of me that grew up with planetary Pluto that's extraordinarily sympathetic to that perspective. But including Pluto as a planet necessarily results in a Solar System with far more than nine planets. Pluto is only the 8th largest non-planet in our Solar System, and is clearly a larger-than-average but otherwise typical member of the Kuiper belt. It will never be the 9th planet again.

To be honest, I think this statement isn't true. Can anyone say anything about this article?

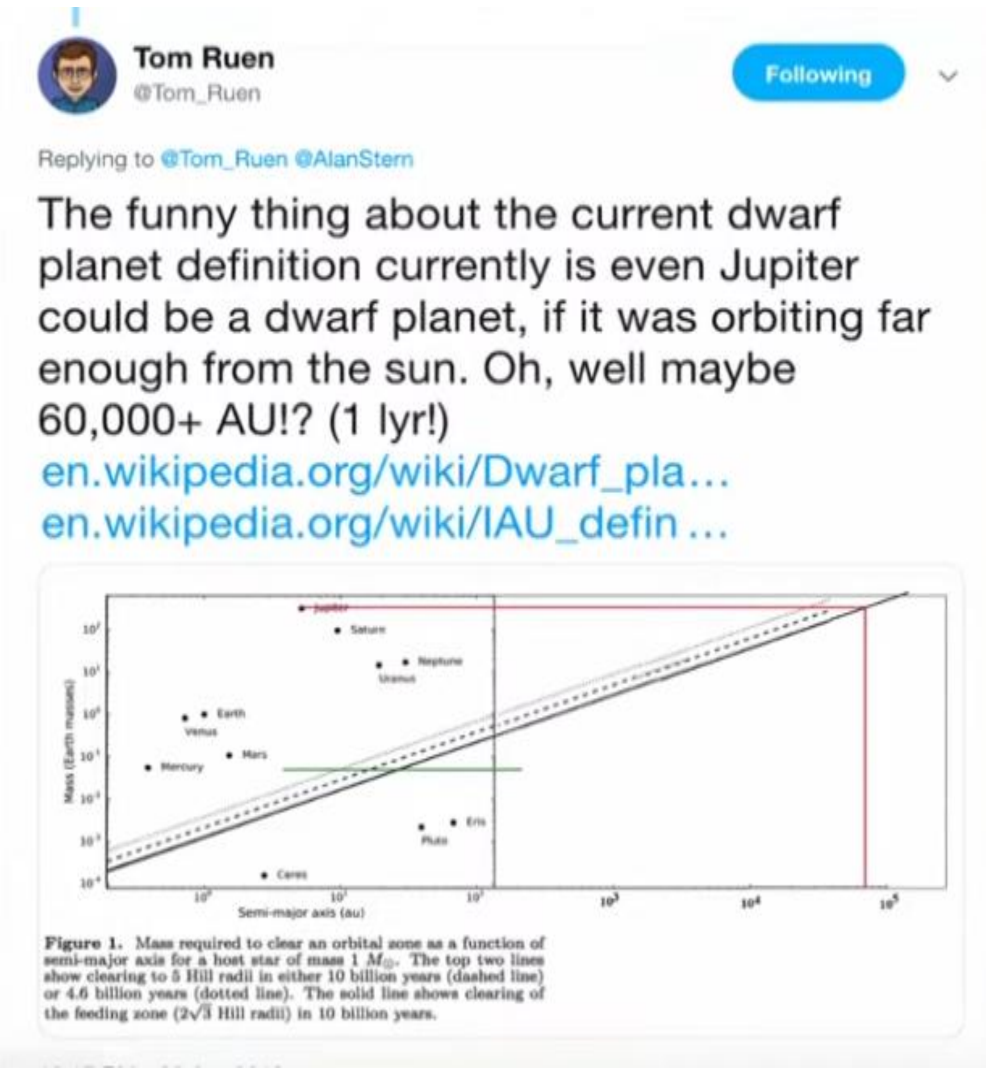
Now, let's start by piecing the problems together.

Errors In The IAU's Planet Definition

Thanks to Alan Stern, Phil Metzger, and Laurel Kornfeld, and many others, we found out that the IAU's planet definition is really flawed!

According to the International Astronomical Union (IAU), a planet must:

1. ✗ orbit around the Sun (this excludes exoplanets, which are planets that orbit other stars! According to my research, this criteria only applies to our Solar System, but is that a good enough reason? I'm not sure...)
2. ✓ have enough mass to be round (yes, planets have to be big enough to be round, so I'm giving this criteria a tick for that.)
3. ✗ have cleared the neighbourhood in its orbit (this is a really big problem! None of the planets have cleared their orbits as there are more than thousands of asteroids! And oh, about dominating orbits? If Mercury, Venus, Earth, or Mars were placed near Pluto's orbit, then there's no way it would dominate it!)



Tom Ruen
@Tom_Ruen

Replying to @Tom_Ruen @AlanStern

The funny thing about the current dwarf planet definition currently is even Jupiter could be a dwarf planet, if it was orbiting far enough from the sun. Oh, well maybe 60,000+ AU!? (1 lyr!)
en.wikipedia.org/wiki/Dwarf_pla…
en.wikipedia.org/wiki/IAU_defin …

Figure 1. Mass required to clear an orbital zone as a function of semi-major axis for a host star of mass 1 $M_\odot$. The top two lines show clearing to 5 Hill radii in either 10 billion years (dashed line) or 4.6 billion years (dotted line). The solid line shows clearing of the feeding zone ($2\sqrt{3}$ Hill radii) in 10 billion years.

If the third criteria was taken literally, then none of the planets would qualify as planets because of the huge amount of asteroids and space debris orbiting near it!

Also, according to Stern, the third criteria not only disqualifies an object as a planet because of its "insufficient" mass, but also on its location! If Mercury, Venus, Earth, and/or Mars were placed in the Kuiper Belt, there is no way they would qualify as planets, right? It's like when you take a Siberian husky out of Siberia, then there's no way that dog breed would be called a "Siberian husky" anymore, right?

Look at this post on Twitter by Tom Ruen. Yeah, Jupiter would be a dwarf planet if it was orbiting at the Kuiper Belt or further, right?

So identical objects classify differently!
See more of Stern's presentation in the link below.

https://www.youtube.com/watch?v=azbLNSKDQrM&t=1744s

In 2018, scientist Phil Metzger discovered that the IAU's planet definition is ignored by scientists. No science research paper uses the IAU's planet definition, but papers of the IAU's planet definition itself!

However, he found hundreds of those papers using an even better definition — the geophysical planet definition, or the GPD.

In fact, the IPD always fails in professional debates.

Also, Stern said that voting isn't a way of doing science, which I totally agree with. Scientists never vote on continental drift, genetics, evolution, et cetera. As he said it in the link, put 100 scientists in a room and they'd vote if the sky is green, so yeah, this isn't a good way of doing science. But voting is a good way in democracies and government decisions.

The Geophysical Planet Definition (GPD)

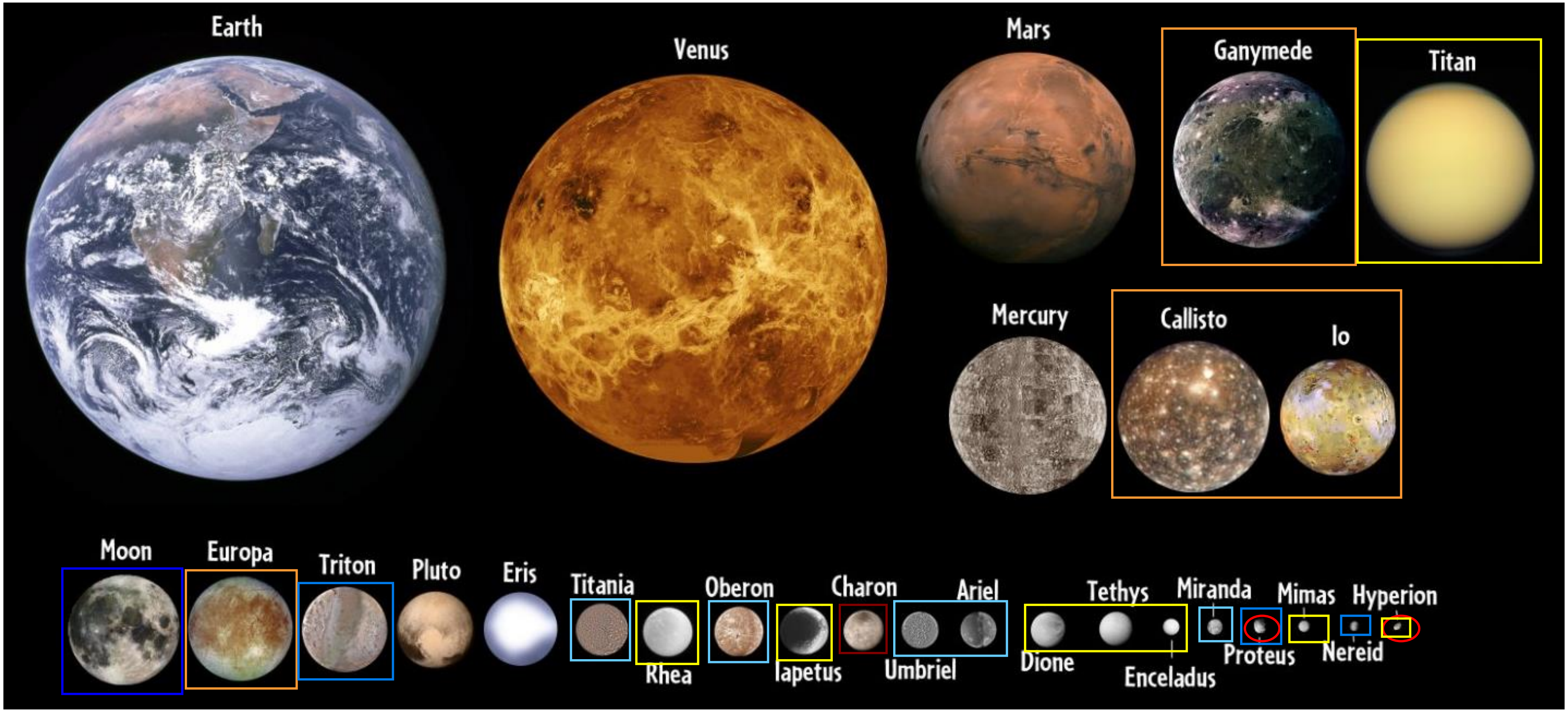
The geophysical planet definition is a better way in defining planets. It is created by planetary scientists, which are actual experts who study planets.
In this case, a planet must:

1. have enough gravitational mass to be round due to hydrostatic equilibrium
2. not have enough mass to emit its own light

Truly, a planet is an astronomical object that orbits a star and does not shine with its own light. If it did shine with its own light, then it would not be a planet, it would be called a star. In this criteria, Pluto and all the other dwarf planets fit in this criteria, so they're planets as well! In reality, the Solar System has not eight planets as the media claimed it to have, but rather hundreds of planets with so many others waiting to be discovered.

By the geophysical planet definition, even the largest moons qualify as planets! But those planets orbit other planets, so they're still moons.

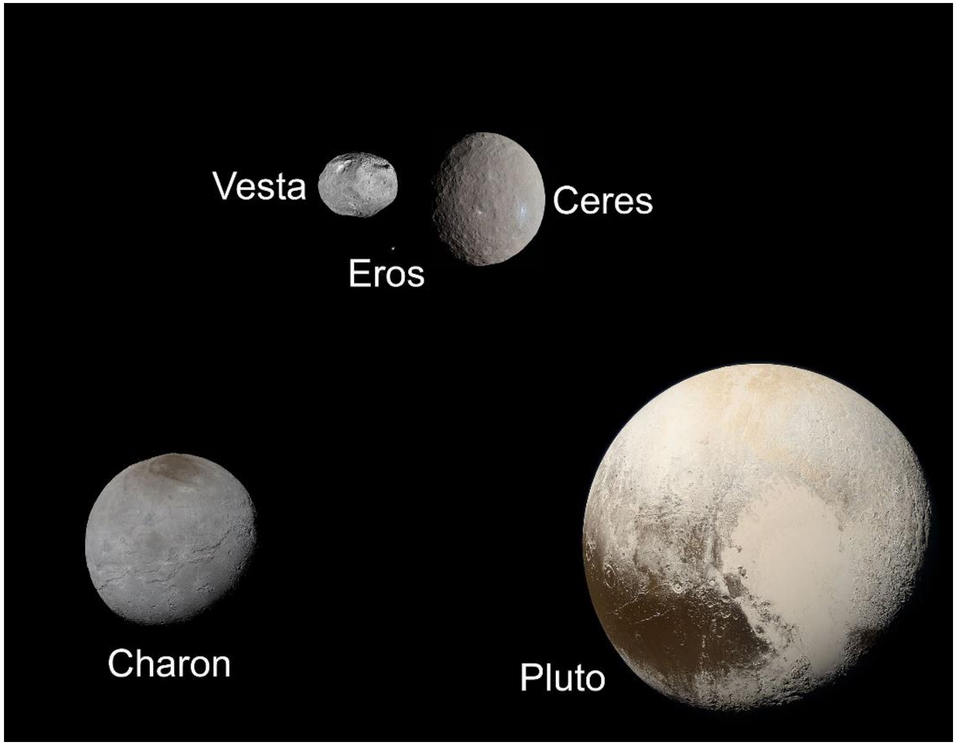
Look at the image below (non-round moons cannot be considered planets and are shown in red circles. Nereid's shape is unknown, maybe it's round, if I'm not wrong!)



Coloured boxes represent the planet that the moons belong to.

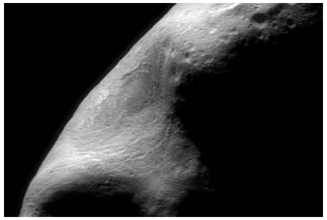
Earth (blue), Jupiter (orange), Saturn (yellow), Uranus (light blue), Neptune (azure blue), Pluto (maroon). Pluto is between Triton (a moon of Neptune) and Eris (a dwarf planet).

By the geophysical planet definition, this disqualifies asteroids because they do not have enough gravitational mass to be round. Neither planets nor asteroids look alike, and a lot of them appear as tiny specks compared to Pluto.



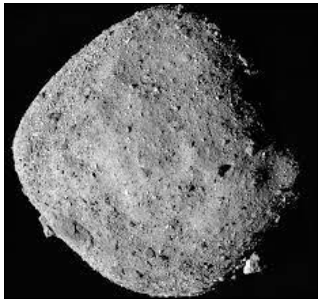
Compare the size of Pluto and its moon Charon to dwarf planet Ceres and protoplanet Vesta. In my point of view, Vesta could become a planet if it had enough mass to be round. (Both Ceres and Vesta could be considered protoplanets, which means first planets.)

A picture of asteroid Ida (left) and its moon Dactyl (right). Some asteroids have their own moons!



A nice close-up view of asteroid Eros, taken by the NEAR Shoemaker spacecraft.

Take a look at asteroid Gaspra (top) and compare its size to possibly captured asteroids Deimos (bottom left) and Phobos (bottom right). Phobos and Deimos are the two moons of Mars.



Asteroid Bennu. This image was taken by the OSIRIS-REx spacecraft. It’s as large as the Empire State Building on Earth!

Statements From Planetary Scientists/GPD Advocates & Others

Time to look at statements from planetary scientists and GPD advocates, as well as some other people! Let's have a look at them now.

I also am gonna add a reaction to some screenshots and videos I see.

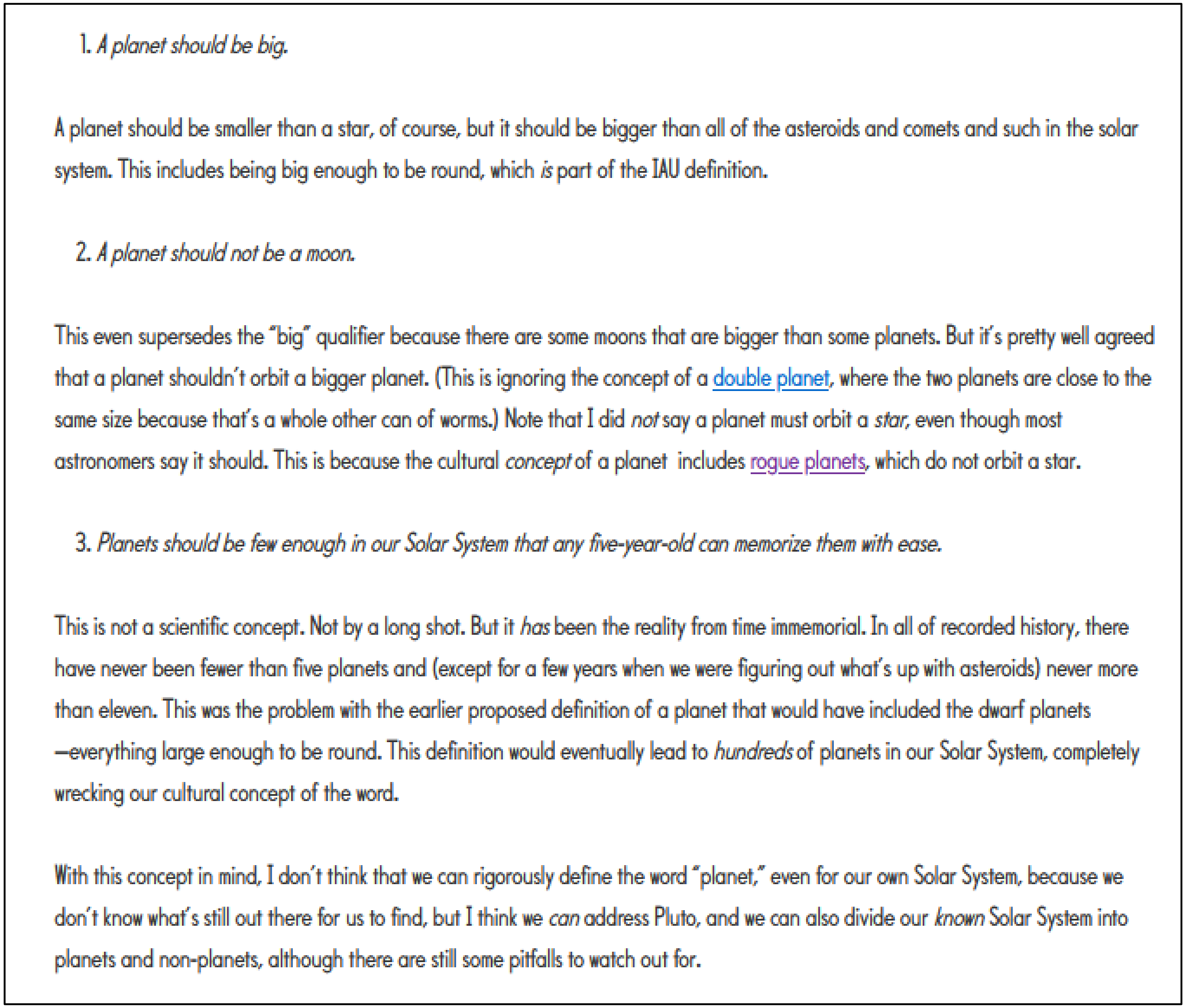
Are we ready to take a look?

Now as I state my opinions, please do not spread hatred towards the ones I'm criticising.

#1 - I took this screenshot from:

Source: https://sciencemeetsfiction.com/nonfiction-essays/the-definition-of-a-planet/

Part I



1. *A planet should be big.*

A planet should be smaller than a star, of course, but it should be bigger than all of the asteroids and comets and such in the solar system. This includes being big enough to be round, which *is* part of the IAU definition.

2. *A planet should not be a moon.*

This even supersedes the "big" qualifier because there are some moons that are bigger than some planets. But it's pretty well agreed that a planet shouldn't orbit a bigger planet. (This is ignoring the concept of a double planet, where the two planets are close to the same size because that's a whole other can of worms.) Note that I did *not* say a planet must orbit a *star*, even though most astronomers say it should. This is because the cultural *concept* of a planet includes rogue planets, which do not orbit a star.

3. *Planets should be few enough in our Solar System that any five-year-old can memorize them with ease.*

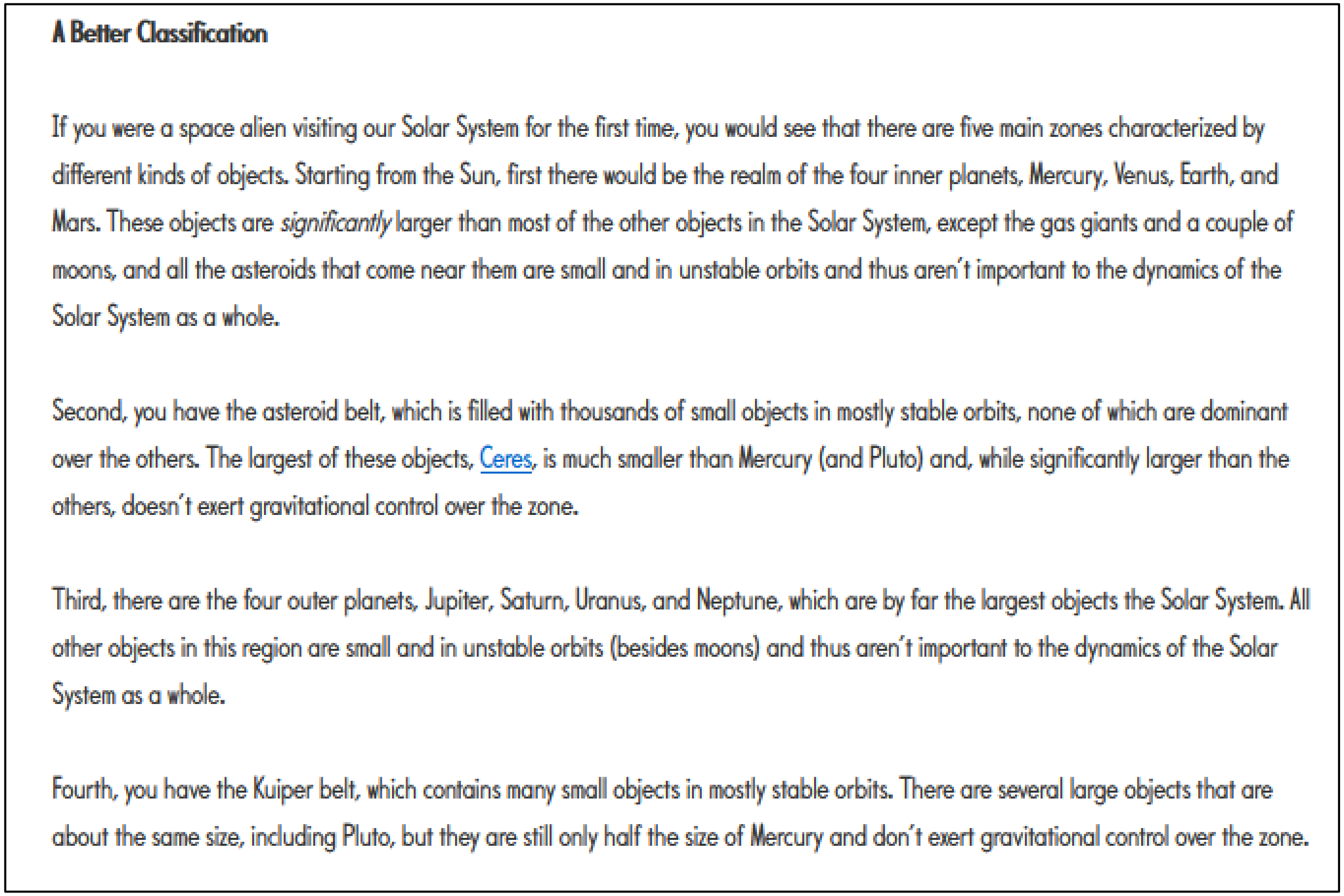
This is not a scientific concept. Not by a long shot. But it *has* been the reality from time immemorial. In all of recorded history, there have never been fewer than five planets and (except for a few years when we were figuring out what's up with asteroids) never more than eleven. This was the problem with the earlier proposed definition of a planet that would have included the dwarf planets—everything large enough to be round. This definition would eventually lead to *hundreds* of planets in our Solar System, completely wrecking our cultural concept of the word.

With this concept in mind, I don't think that we can rigorously define the word "planet," even for our own Solar System, because we don't know what's still out there for us to find, but I think we *can* address Pluto, and we can also divide our *known* Solar System into planets and non-planets, although there are still some pitfalls to watch out for.

#1 - I took this screenshot from:

https://sciencemeetsfiction.com/nonfiction-essays/the-definition-of-a-planet/

Part II



A Better Classification

If you were a space alien visiting our Solar System for the first time, you would see that there are five main zones characterized by different kinds of objects. Starting from the Sun, first there would be the realm of the four inner planets, Mercury, Venus, Earth, and Mars. These objects are *significantly* larger than most of the other objects in the Solar System, except the gas giants and a couple of moons, and all the asteroids that come near them are small and in unstable orbits and thus aren't important to the dynamics of the Solar System as a whole.

Second, you have the asteroid belt, which is filled with thousands of small objects in mostly stable orbits, none of which are dominant over the others. The largest of these objects, Ceres, is much smaller than Mercury (and Pluto) and, while significantly larger than the others, doesn't exert gravitational control over the zone.

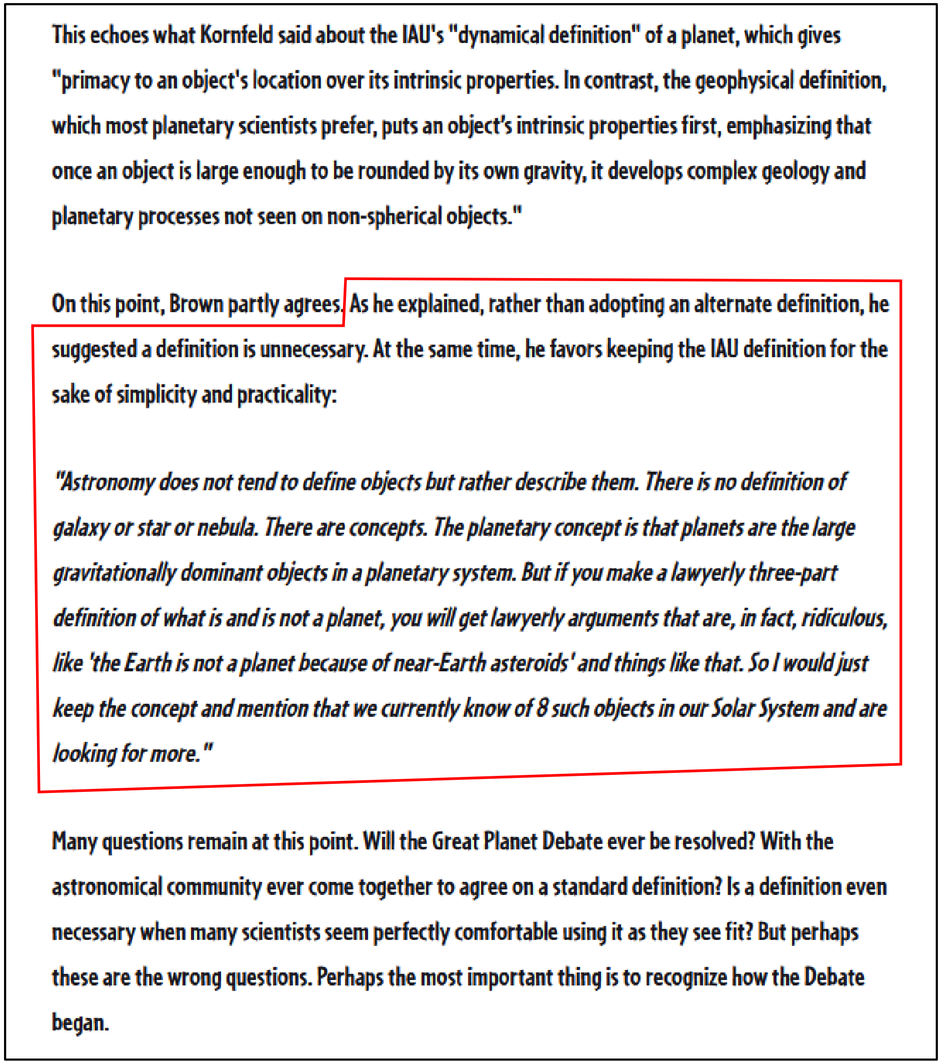
Third, there are the four outer planets, Jupiter, Saturn, Uranus, and Neptune, which are by far the largest objects the Solar System. All other objects in this region are small and in unstable orbits (besides moons) and thus aren't important to the dynamics of the Solar System as a whole.

Fourth, you have the Kuiper belt, which contains many small objects in mostly stable orbits. There are several large objects that are about the same size, including Pluto, but they are still only half the size of Mercury and don't exert gravitational control over the zone.

It's true that a planet should be big enough to be round, but once again, Mercury would not be able to clear its orbit if it were placed near the orbit of Pluto. Laurel Kornfeld said that it is unclear whether Mercury and Venus have cleared their orbits or the Sun is clearing their orbits, that's why they both don't have moons, I guess!

#2 - I took this screenshot from:

https://interestingengineering.com/science/the-great-planet-debate-is-it-over-will-it-ever-be



This echoes what Kornfeld said about the IAU's "dynamical definition" of a planet, which gives "primacy to an object's location over its intrinsic properties. In contrast, the geophysical definition, which most planetary scientists prefer, puts an object's intrinsic properties first, emphasizing that once an object is large enough to be rounded by its own gravity, it develops complex geology and planetary processes not seen on non-spherical objects."

On this point, Brown partly agrees. As he explained, rather than adopting an alternate definition, he suggested a definition is unnecessary. At the same time, he favors keeping the IAU definition for the sake of simplicity and practicality:

"Astronomy does not tend to define objects but rather describe them. There is no definition of galaxy or star or nebula. There are concepts. The planetary concept is that planets are the large gravitationally dominant objects in a planetary system. But if you make a lawyerly three-part definition of what is and is not a planet, you will get lawyerly arguments that are, in fact, ridiculous, like 'the Earth is not a planet because of near-Earth asteroids' and things like that. So I would just keep the concept and mention that we currently know of 8 such objects in our Solar System and are looking for more."

Many questions remain at this point. Will the Great Planet Debate ever be resolved? With the astronomical community ever come together to agree on a standard definition? Is a definition even necessary when many scientists seem perfectly comfortable using it as they see fit? But perhaps these are the wrong questions. Perhaps the most important thing is to recognize how the Debate began.

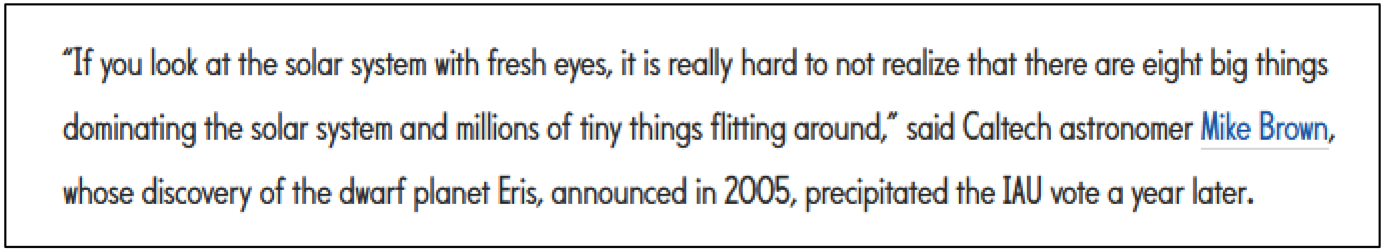
"Gravitationally dominant?" Mike Brown, answer this question. If a terrestrial planet like Mercury or Earth was placed at the Kuiper Belt, how can it be gravitationally dominant? I do agree that it would be ridiculous if Earth weren't classified as a planet because of asteroids orbiting around it, and if you're referring to "8 such objects" in our Solar System, then you're referring to eight of the nine largest planets in our Solar System. If your "Planet Nine" exists at the Kuiper Belt, would it be able to "gravitationally dominate" its orbit?

#3 - I took this screenshot from:

https://www.washingtonpost.com/news/speaking-of-science/wp/2017/03/20/a-new-definition-would-add-102-planets-to-our-solar-system-including-pluto/

Planetary scientist Kirby Runyon stated that the IAU's definition of a planet is like religion and politics. However, Carolyn Porco, a planetary scientist who led the imaging science team on the Cassini mission in orbit around Saturn, stated that "a classification has to be useful, or else it's just lipstick on a pig."

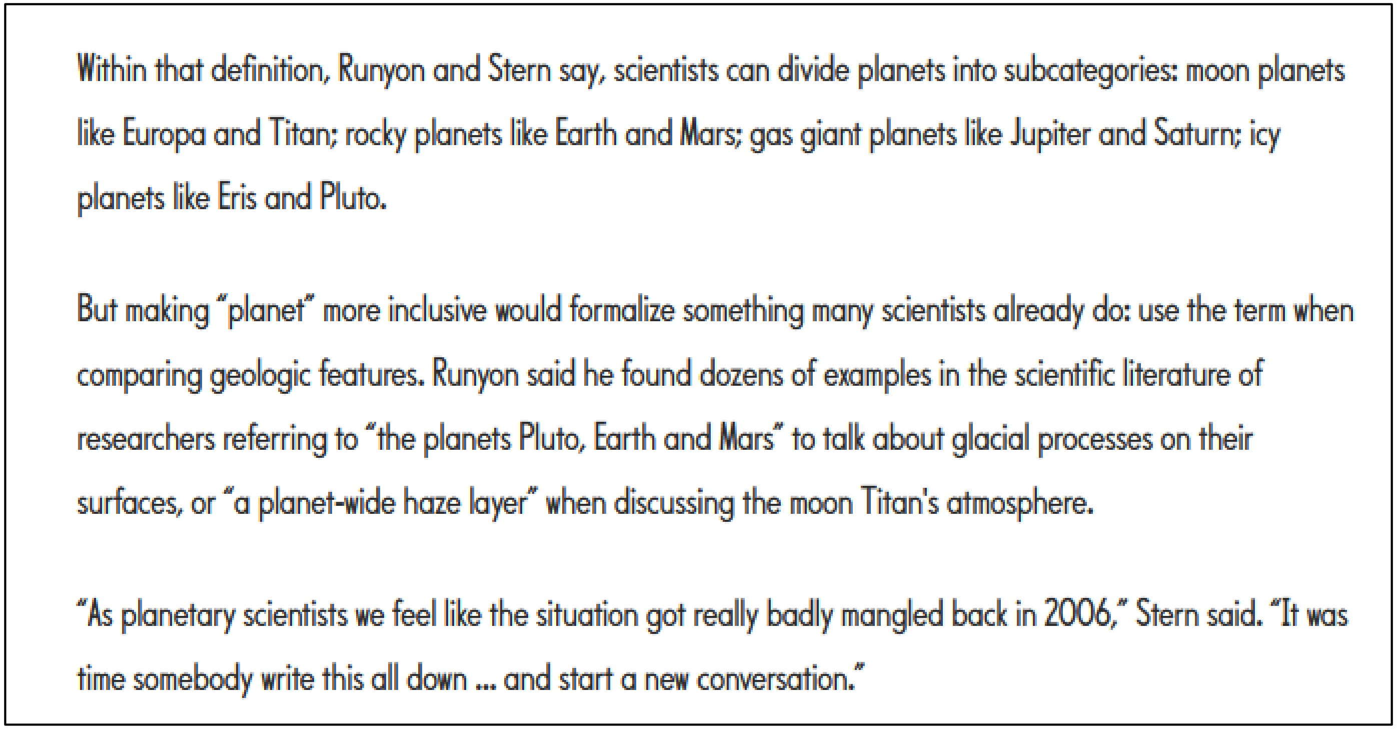
But take a look at this!



"If you look at the solar system with fresh eyes, it is really hard to not realize that there are eight big things dominating the solar system and millions of tiny things flitting around," said Caltech astronomer Mike Brown, whose discovery of the dwarf planet Eris, announced in 2005, precipitated the IAU vote a year later.

#3 - I took this screenshot from:

https://www.washingtonpost.com/news/speaking-of-science/wp/2017/03/20/a-new-definition-would-add-102-planets-to-our-solar-system-including-pluto/



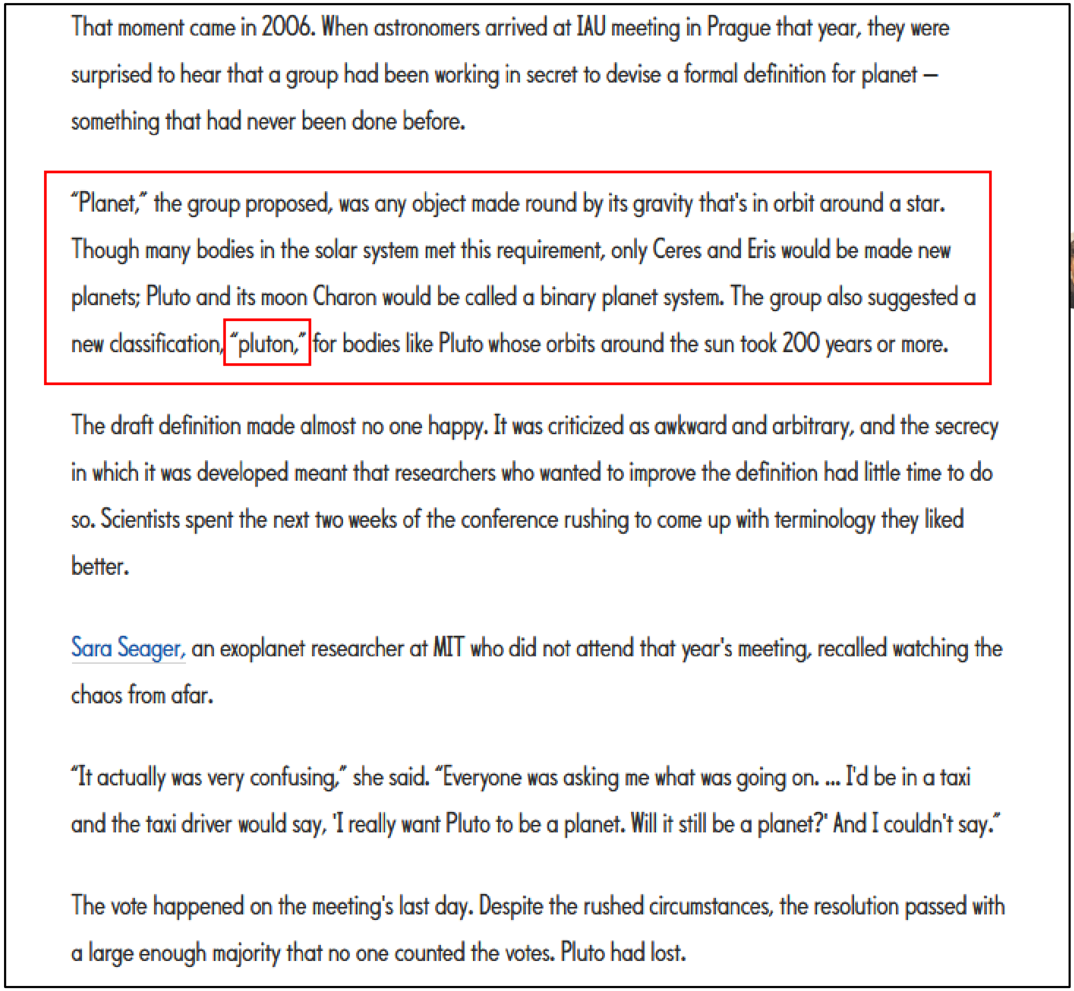
Within that definition, Runyon and Stern say, scientists can divide planets into subcategories: moon planets like Europa and Titan; rocky planets like Earth and Mars; gas giant planets like Jupiter and Saturn; icy planets like Eris and Pluto.

But making "planet" more inclusive would formalize something many scientists already do: use the term when comparing geologic features. Runyon said he found dozens of examples in the scientific literature of researchers referring to "the planets Pluto, Earth and Mars" to talk about glacial processes on their surfaces, or "a planet-wide haze layer" when discussing the moon Titan's atmosphere.

"As planetary scientists we feel like the situation got really badly mangled back in 2006," Stern said. "It was time somebody write this all down ... and start a new conversation."

#3 - I took this screenshot from:

https://www.washingtonpost.com/news/speaking-of-science/wp/2017/03/20/a-new-definition-would-add-102-planets-to-our-solar-system-including-pluto/



That moment came in 2006. When astronomers arrived at IAU meeting in Prague that year, they were surprised to hear that a group had been working in secret to devise a formal definition for planet – something that had never been done before.

"Planet," the group proposed, was any object made round by its gravity that's in orbit around a star. Though many bodies in the solar system met this requirement, only Ceres and Eris would be made new planets; Pluto and its moon Charon would be called a binary planet system. The group also suggested a new classification, "pluton," for bodies like Pluto whose orbits around the sun took 200 years or more.

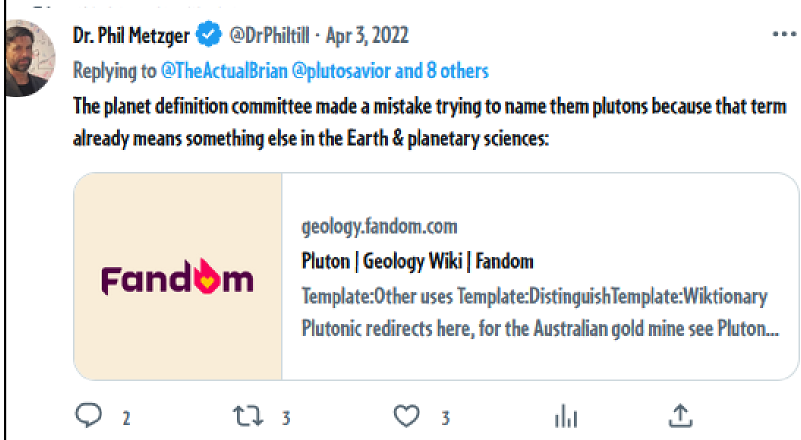
The draft definition made almost no one happy. It was criticized as awkward and arbitrary, and the secrecy in which it was developed meant that researchers who wanted to improve the definition had little time to do so. Scientists spent the next two weeks of the conference rushing to come up with terminology they liked better.

Sara Seager, an exoplanet researcher at MIT who did not attend that year's meeting, recalled watching the chaos from afar.

"It actually was very confusing," she said. "Everyone was asking me what was going on. ... I'd be in a taxi and the taxi driver would say, 'I really want Pluto to be a planet. Will it still be a planet?' And I couldn't say."

The vote happened on the meeting's last day. Despite the rushed circumstances, the resolution passed with a large enough majority that no one counted the votes. Pluto had lost.

Phil Metzger said that the word "pluton" refers to something that already exists in the Earth.



Dr. Phil Metzger @DrPhiltill · Apr 3, 2022

Replying to @TheActualBrian @plutosavior and 8 others

The planet definition committee made a mistake trying to name them plutons because that term already means something else in the Earth & planetary sciences:

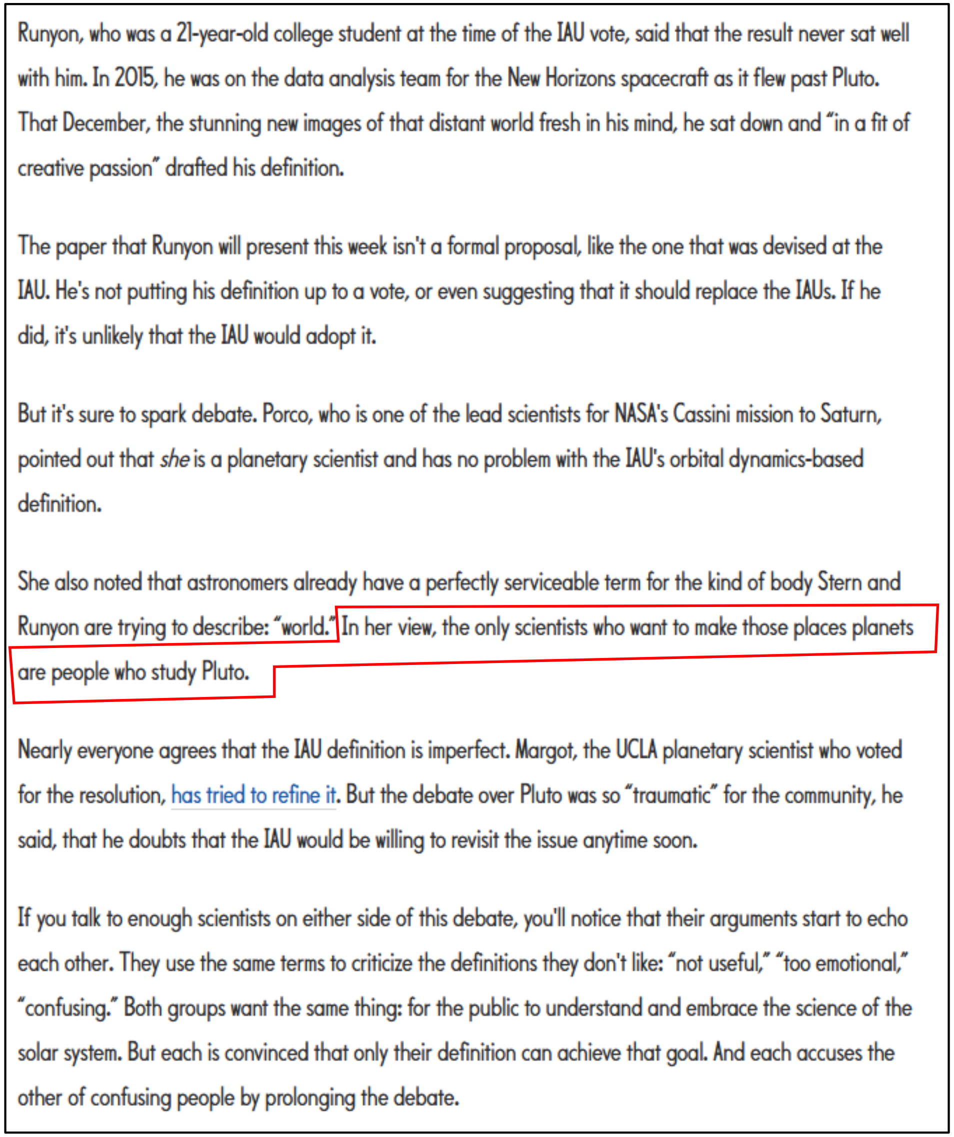
geology.fandom.com

Pluton | Geology Wiki | Fandom

Template:Other uses Template:DistinguishTemplate:Wiktionary Plutonic redirects here, for the Australian gold mine see Pluton...

#3 - I took this screenshot from:

https://www.washingtonpost.com/news/speaking-of-science/wp/2017/03/20/a-new-definition-would-add-102-planets-to-our-solar-system-including-pluto/



Runyon, who was a 21-year-old college student at the time of the IAU vote, said that the result never sat well with him. In 2015, he was on the data analysis team for the New Horizons spacecraft as it flew past Pluto. That December, the stunning new images of that distant world fresh in his mind, he sat down and "in a fit of creative passion" drafted his definition.

The paper that Runyon will present this week isn't a formal proposal, like the one that was devised at the IAU. He's not putting his definition up to a vote, or even suggesting that it should replace the IAUs. If he did, it's unlikely that the IAU would adopt it.

But it's sure to spark debate. Porco, who is one of the lead scientists for NASA's Cassini mission to Saturn, pointed out that *she* is a planetary scientist and has no problem with the IAU's orbital dynamics-based definition.

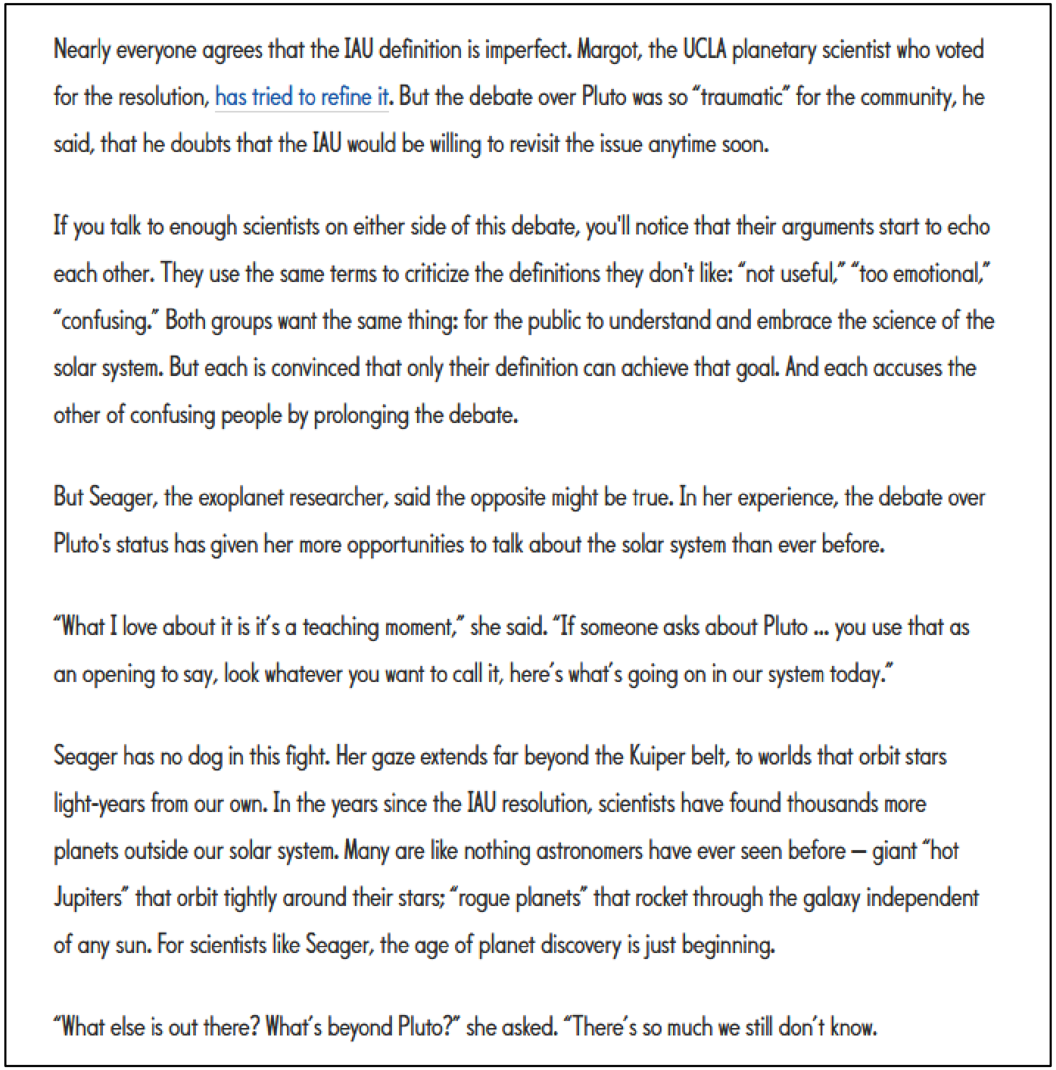
She also noted that astronomers already have a perfectly serviceable term for the kind of body Stern and Runyon are trying to describe: "world." In her view, the only scientists who want to make those places planets are people who study Pluto.

Nearly everyone agrees that the IAU definition is imperfect. Margot, the UCLA planetary scientist who voted for the resolution, has tried to refine it. But the debate over Pluto was so "traumatic" for the community, he said, that he doubts that the IAU would be willing to revisit the issue anytime soon.

If you talk to enough scientists on either side of this debate, you'll notice that their arguments start to echo each other. They use the same terms to criticize the definitions they don't like: "not useful," "too emotional," "confusing." Both groups want the same thing: for the public to understand and embrace the science of the solar system. But each is convinced that only their definition can achieve that goal. And each accuses the other of confusing people by prolonging the debate.

#3 - I took this screenshot from:

https://www.washingtonpost.com/news/speaking-of-science/wp/2017/03/20/a-new-definition-would-add-102-planets-to-our-solar-system-including-pluto/



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But Seager, the exoplanet researcher, said the opposite might be true. In her experience, the debate over Pluto's status has given her more opportunities to talk about the solar system than ever before.

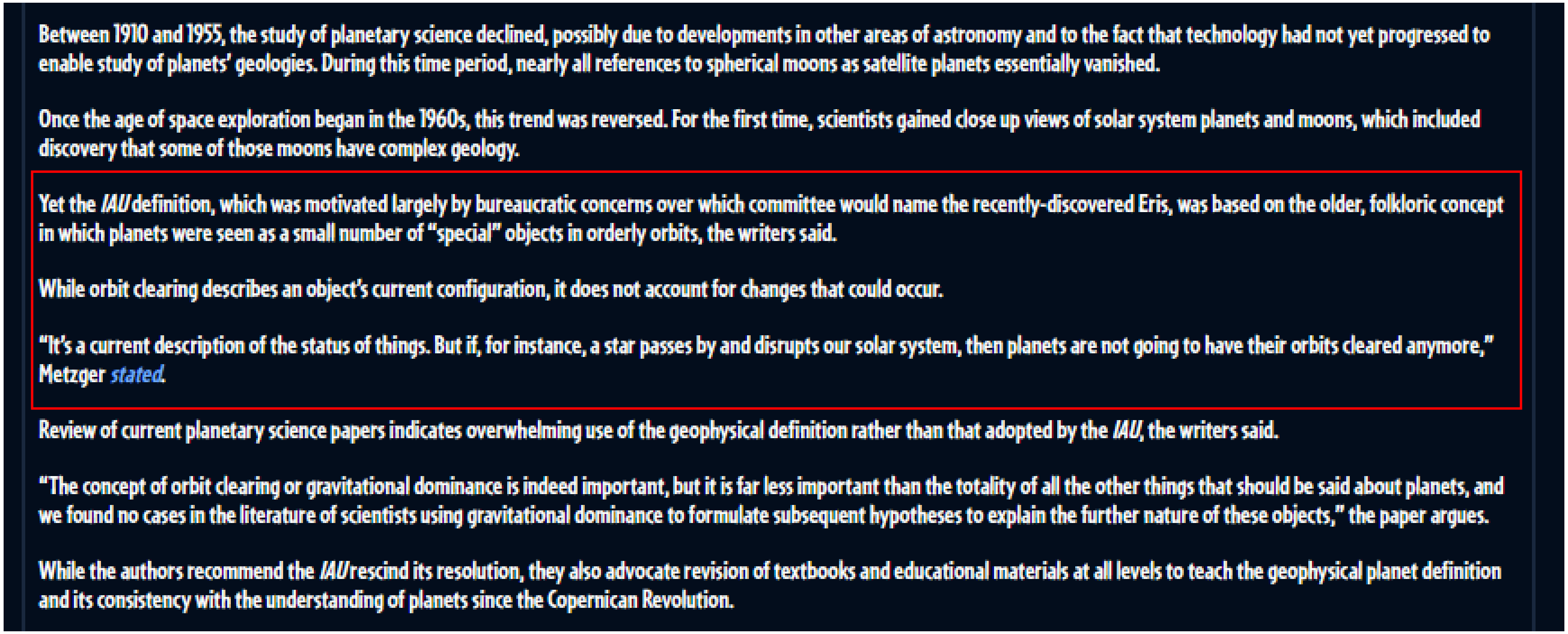
"What I love about it is it's a teaching moment," she said. "If someone asks about Pluto ... you use that as an opening to say, look whatever you want to call it, here's what's going on in our system today."

Seager has no dog in this fight. Her gaze extends far beyond the Kuiper belt, to worlds that orbit stars light-years from our own. In the years since the IAU resolution, scientists have found thousands more planets outside our solar system. Many are like nothing astronomers have ever seen before — giant "hot Jupiters" that orbit tightly around their stars; "rogue planets" that rocket through the galaxy independent of any sun. For scientists like Seager, the age of planet discovery is just beginning.

"What else is out there? What's beyond Pluto?" she asked. "There's so much we still don't know.

#4 - I took this screenshot from:

https://www.spaceflightinsider.com/missions/solar-system/study-makes-case-for-geophysical-planet-definition/



Between 1910 and 1955, the study of planetary science declined, possibly due to developments in other areas of astronomy and to the fact that technology had not yet progressed to enable study of planets' geologies. During this time period, nearly all references to spherical moons as satellite planets essentially vanished.

Once the age of space exploration began in the 1960s, this trend was reversed. For the first time, scientists gained close up views of solar system planets and moons, which included discovery that some of those moons have complex geology.

Yet the *IAU* definition, which was motivated largely by bureaucratic concerns over which committee would name the recently-discovered Eris, was based on the older, folkloric concept in which planets were seen as a small number of "special" objects in orderly orbits, the writers said.

While orbit clearing describes an object's current configuration, it does not account for changes that could occur.

"It's a current description of the status of things. But if, for instance, a star passes by and disrupts our solar system, then planets are not going to have their orbits cleared anymore," Metzger *stated*.

Review of current planetary science papers indicates overwhelming use of the geophysical definition rather than that adopted by the *IAU*, the writers said.

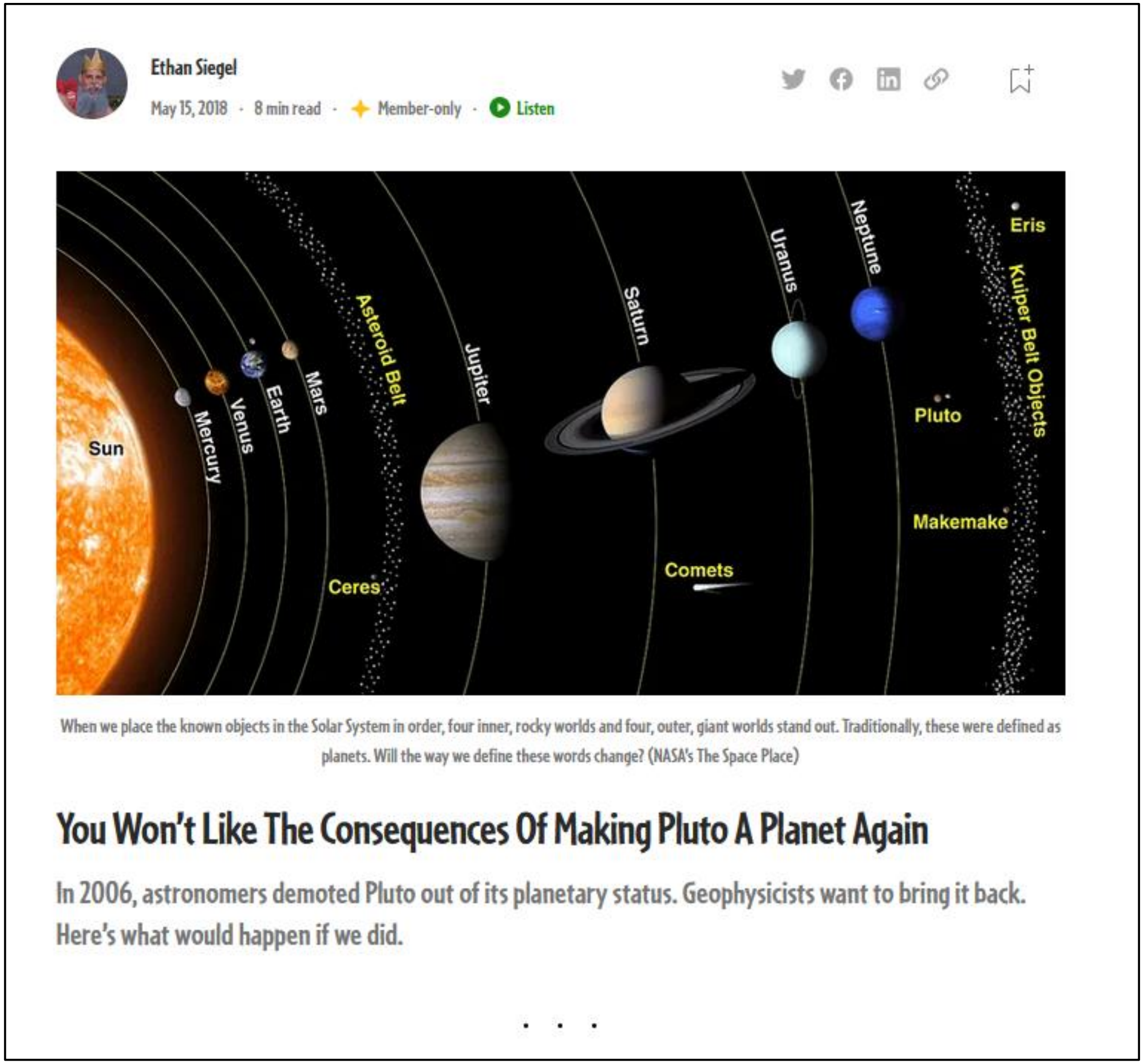
"The concept of orbit clearing or gravitational dominance is indeed important, but it is far less important than the totality of all the other things that should be said about planets, and we found no cases in the literature of scientists using gravitational dominance to formulate subsequent hypotheses to explain the further nature of these objects," the paper argues.

While the authors recommend the *IAU* rescind its resolution, they also advocate revision of textbooks and educational materials at all levels to teach the geophysical planet definition and its consistency with the understanding of planets since the Copernican Revolution.

Good reasoning, Dr. Metzger!

#5 - I took this screenshot from:

https://medium.com/starts-with-a-bang/you-wont-like-the-consequences-of-making-pluto-a-planet-again-3019b2077129



Ethan Siegel

May 15, 2018 · 8 min read · ✦ Member-only · ▶ Listen

When we place the known objects in the Solar System in order, four inner, rocky worlds and four, outer, giant worlds stand out. Traditionally, these were defined as planets. Will the way we define these words change? (NASA's The Space Place)

You Won't Like The Consequences Of Making Pluto A Planet Again

In 2006, astronomers demoted Pluto out of its planetary status. Geophysicists want to bring it back. Here's what would happen if we did.

· · ·

Same guy who stated that Pluto will never be a planet again (see page 9).

"You won't like the consequences of making Pluto a planet again," would I? Well, the simple answer is, I don't actually give a damn if our Solar System has more than nine planets! I actually like all those consequences if we consider Pluto a planet, bud.

#5 - I took this screenshot from:

https://medium.com/starts-with-a-bang/you-wont-like-the-consequences-of-making-pluto-a-planet-again-3019b2077129

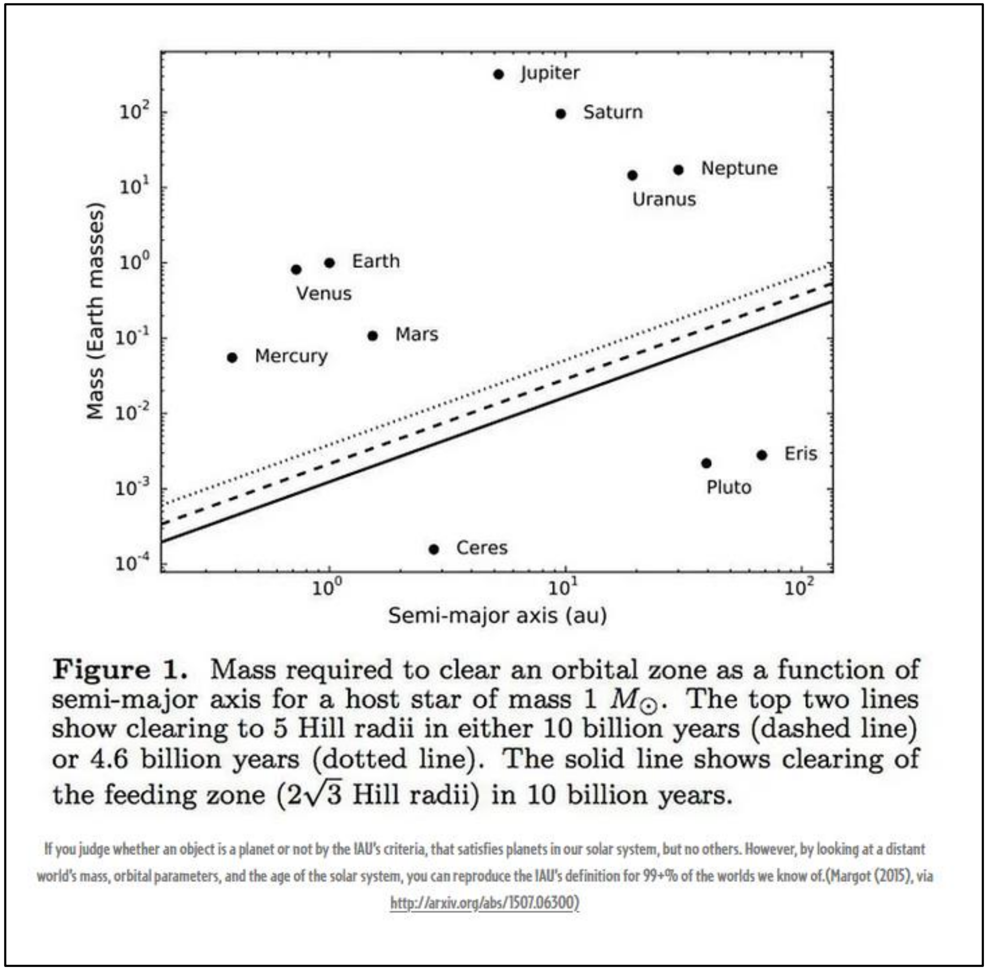


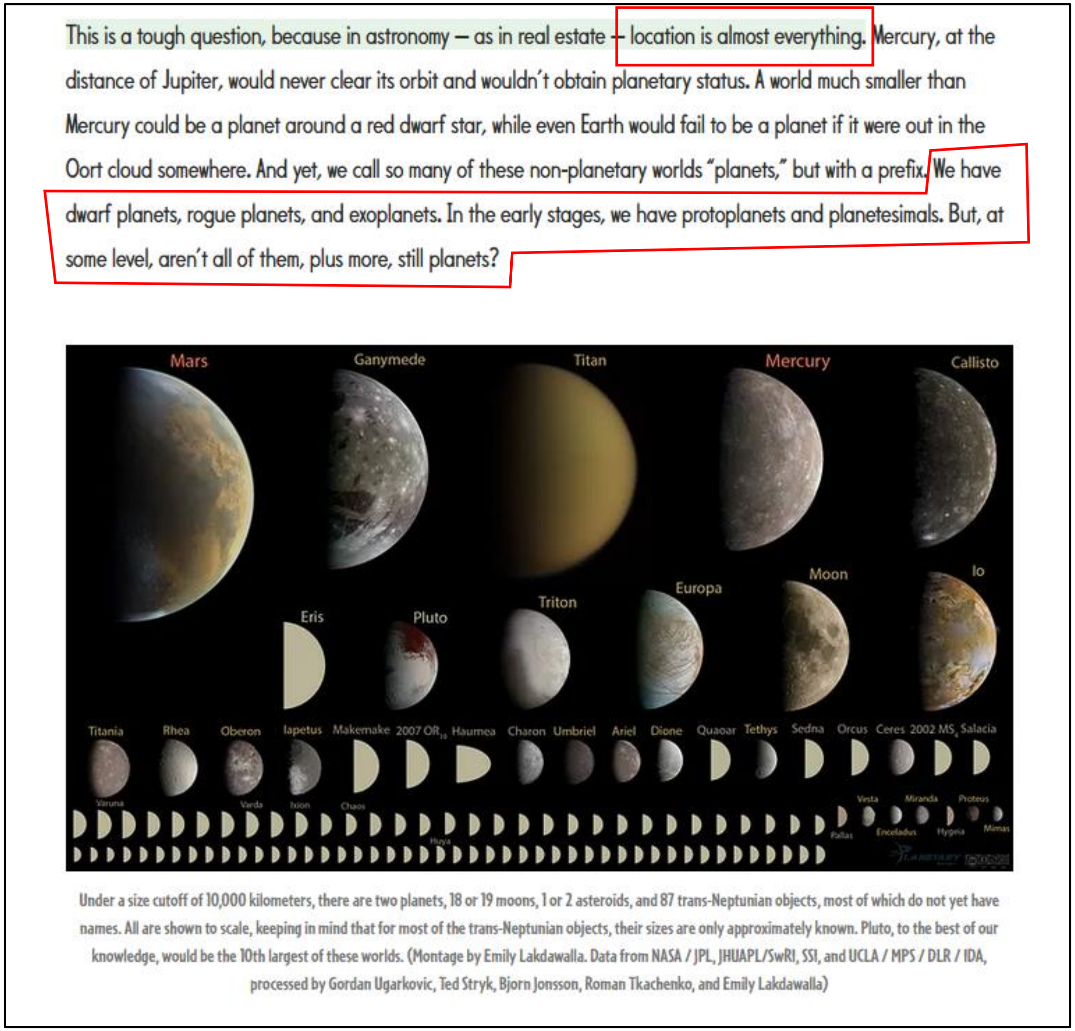
Figure 1. Mass required to clear an orbital zone as a function of semi-major axis for a host star of mass 1 $M_\odot$. The top two lines show clearing to 5 Hill radii in either 10 billion years (dashed line) or 4.6 billion years (dotted line). The solid line shows clearing of the feeding zone ($2\sqrt{3}$ Hill radii) in 10 billion years.

If you judge whether an object is a planet or not by the IAU's criteria, that satisfies planets in our solar system, but no others. However, by looking at a distant world's mass, orbital parameters, and the age of the solar system, you can reproduce the IAU's definition for 99+% of the worlds we know of.(Margot (2015), via http://arxiv.org/abs/1507.06300)

This diagram turned out to be flawed. (see page 11). Put Mercury in the Kuiper Belt or further, then according to this, it would be a dwarf planet! Even the biggest planet, Jupiter, as well!

#5 - I took this screenshot from:

https://medium.com/starts-with-a-bang/you-wont-like-the-consequences-of-making-pluto-a-planet-again-3019b2077129



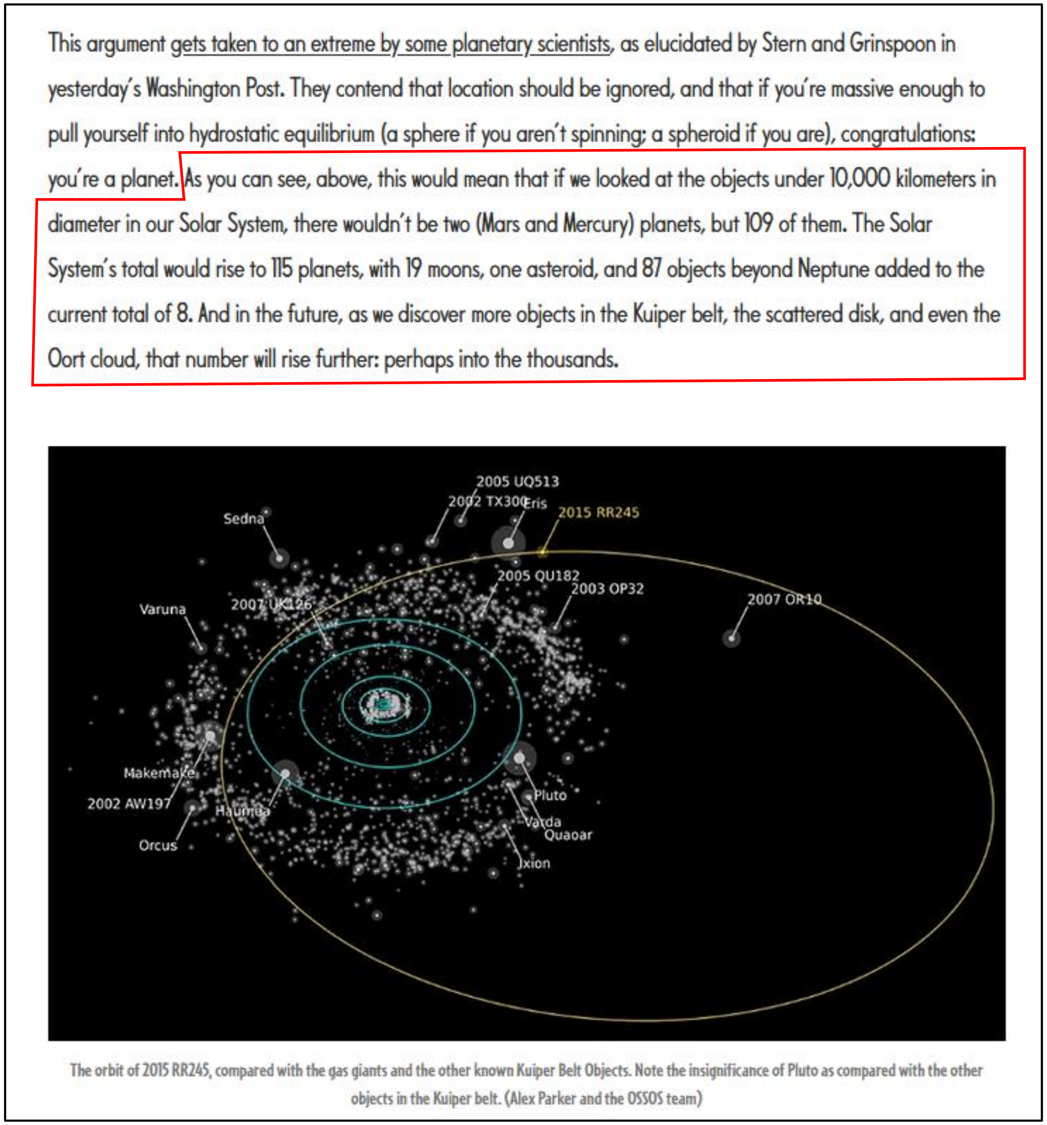
This is a tough question, because in astronomy — as in real estate — location is almost everything. Mercury, at the distance of Jupiter, would never clear its orbit and wouldn't obtain planetary status. A world much smaller than Mercury could be a planet around a red dwarf star, while even Earth would fail to be a planet if it were out in the Oort cloud somewhere. And yet, we call so many of these non-planetary worlds "planets," but with a prefix. We have dwarf planets, rogue planets, and exoplanets. In the early stages, we have protoplanets and planetesimals. But, at some level, aren't all of them, plus more, still planets?

Under a size cutoff of 10,000 kilometers, there are two planets, 18 or 19 moons, 1 or 2 asteroids, and 87 trans-Neptunian objects, most of which do not yet have names. All are shown to scale, keeping in mind that for most of the trans-Neptunian objects, their sizes are only approximately known. Pluto, to the best of our knowledge, would be the 10th largest of these worlds. (Montage by Emily Lakdawalla. Data from NASA / JPL, JHUAPL/SwRI, SSI, and UCLA / MPS / DLR / IDA, processed by Gordan Ugarkovic, Ted Stryk, Bjorn Jonsson, Roman Tkachenko, and Emily Lakdawalla)

"Location is almost everything?"

#5 - I took this screenshot from:

https://medium.com/starts-with-a-bang/you-wont-like-the-consequences-of-making-pluto-a-planet-again-3019b2077129



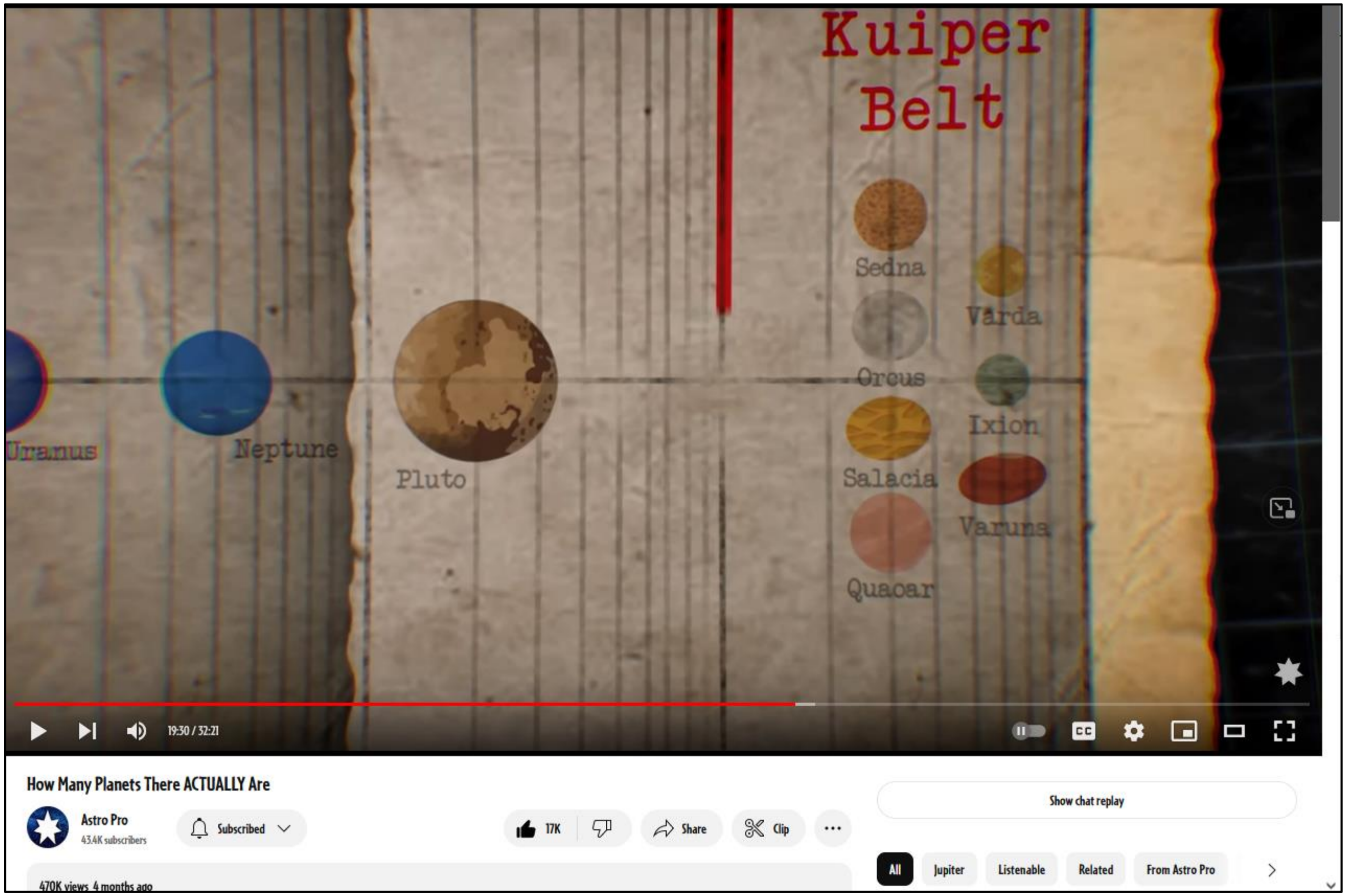
This argument gets taken to an extreme by some planetary scientists, as elucidated by Stern and Grinspoon in yesterday's Washington Post. They contend that location should be ignored, and that if you're massive enough to pull yourself into hydrostatic equilibrium (a sphere if you aren't spinning; a spheroid if you are), congratulations: you're a planet. As you can see, above, this would mean that if we looked at the objects under 10,000 kilometers in diameter in our Solar System, there wouldn't be two (Mars and Mercury) planets, but 109 of them. The Solar System's total would rise to 115 planets, with 19 moons, one asteroid, and 87 objects beyond Neptune added to the current total of 8. And in the future, as we discover more objects in the Kuiper belt, the scattered disk, and even the Oort cloud, that number will rise further: perhaps into the thousands.

The orbit of 2015 RR245, compared with the gas giants and the other known Kuiper Belt Objects. Note the insignificance of Pluto as compared with the other objects in the Kuiper belt. (Alex Parker and the OSSOS team)

Who cares if there are 115 planets or more in total? Obviously, I think this guy is scared of having "too many planets" in the Solar System.

#6 - I took this screenshot from:

https://www.youtube.com/watch?v=UyK4MTeJJrQ



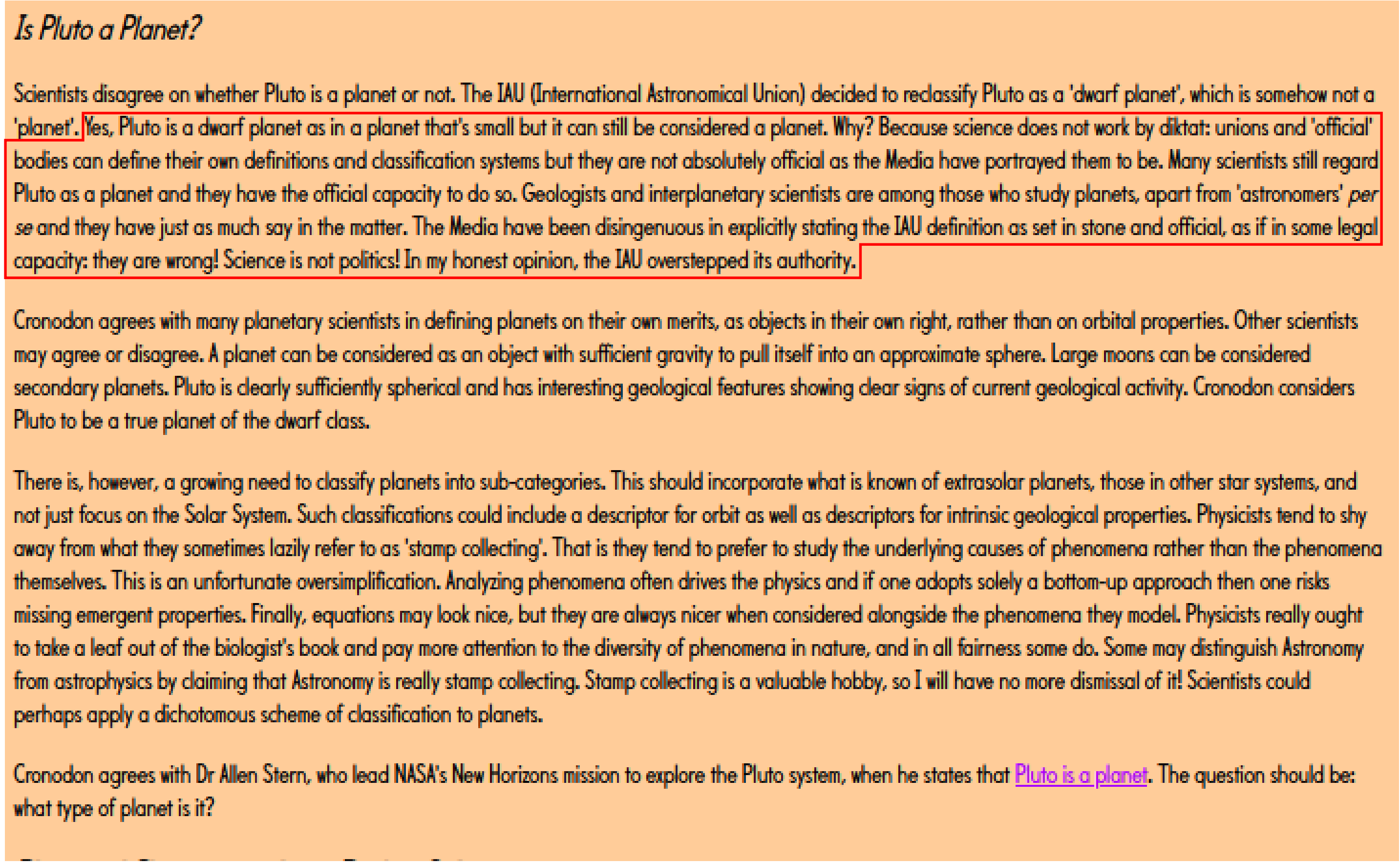
How Many Planets There ACTUALLY Are

470K views 4 months ago

YouTuber Astro Pro has created a wonderful video explaining how many planets there actually are and the "demotion" of Pluto. You can watch the video in the link above and express your opinions.

#7 - I took this screenshot from:

https://www.cronodon.com/PlanetTech/pluto.html



Is Pluto a Planet?

Scientists disagree on whether Pluto is a planet or not. The IAU (International Astronomical Union) decided to reclassify Pluto as a 'dwarf planet', which is somehow not a 'planet'. Yes, Pluto is a dwarf planet as in a planet that's small but it can still be considered a planet. Why? Because science does not work by diktat: unions and 'official' bodies can define their own definitions and classification systems but they are not absolutely official as the Media have portrayed them to be. Many scientists still regard Pluto as a planet and they have the official capacity to do so. Geologists and interplanetary scientists are among those who study planets, apart from 'astronomers' *per se* and they have just as much say in the matter. The Media have been disingenuous in explicitly stating the IAU definition as set in stone and official, as if in some legal capacity: they are wrong! Science is not politics! In my honest opinion, the IAU overstepped its authority.

Cronodon agrees with many planetary scientists in defining planets on their own merits, as objects in their own right, rather than on orbital properties. Other scientists may agree or disagree. A planet can be considered as an object with sufficient gravity to pull itself into an approximate sphere. Large moons can be considered secondary planets. Pluto is clearly sufficiently spherical and has interesting geological features showing clear signs of current geological activity. Cronodon considers Pluto to be a true planet of the dwarf class.

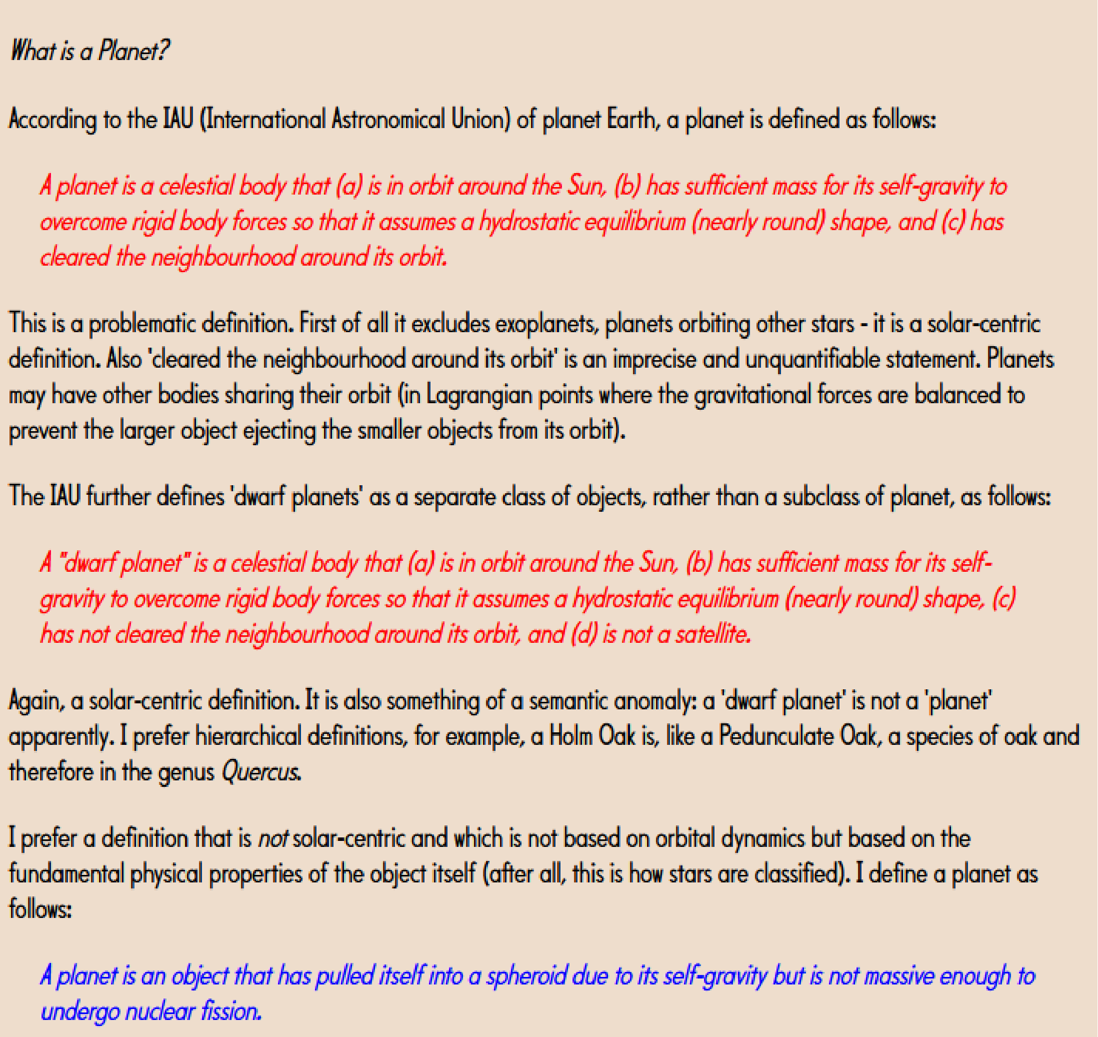
There is, however, a growing need to classify planets into sub-categories. This should incorporate what is known of extrasolar planets, those in other star systems, and not just focus on the Solar System. Such classifications could include a descriptor for orbit as well as descriptors for intrinsic geological properties. Physicists tend to shy away from what they sometimes lazily refer to as 'stamp collecting'. That is they tend to prefer to study the underlying causes of phenomena rather than the phenomena themselves. This is an unfortunate oversimplification. Analyzing phenomena often drives the physics and if one adopts solely a bottom-up approach then one risks missing emergent properties. Finally, equations may look nice, but they are always nicer when considered alongside the phenomena they model. Physicists really ought to take a leaf out of the biologist's book and pay more attention to the diversity of phenomena in nature, and in all fairness some do. Some may distinguish Astronomy from astrophysics by claiming that Astronomy is really stamp collecting. Stamp collecting is a valuable hobby, so I will have no more dismissal of it! Scientists could perhaps apply a dichotomous scheme of classification to planets.

Cronodon agrees with Dr Allen Stern, who lead NASA's New Horizons mission to explore the Pluto system, when he states that Pluto is a planet. The question should be: what type of planet is it?

Something that I definitely agree with!

#7 - I took this screenshot from:

https://www.cronodon.com/PlanetTech/solar-system.html



What is a Planet?

According to the IAU (International Astronomical Union) of planet Earth, a planet is defined as follows:

> *A planet is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit.*

This is a problematic definition. First of all it excludes exoplanets, planets orbiting other stars - it is a solar-centric definition. Also 'cleared the neighbourhood around its orbit' is an imprecise and unquantifiable statement. Planets may have other bodies sharing their orbit (in Lagrangian points where the gravitational forces are balanced to prevent the larger object ejecting the smaller objects from its orbit).

The IAU further defines 'dwarf planets' as a separate class of objects, rather than a subclass of planet, as follows:

> *A "dwarf planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite.*

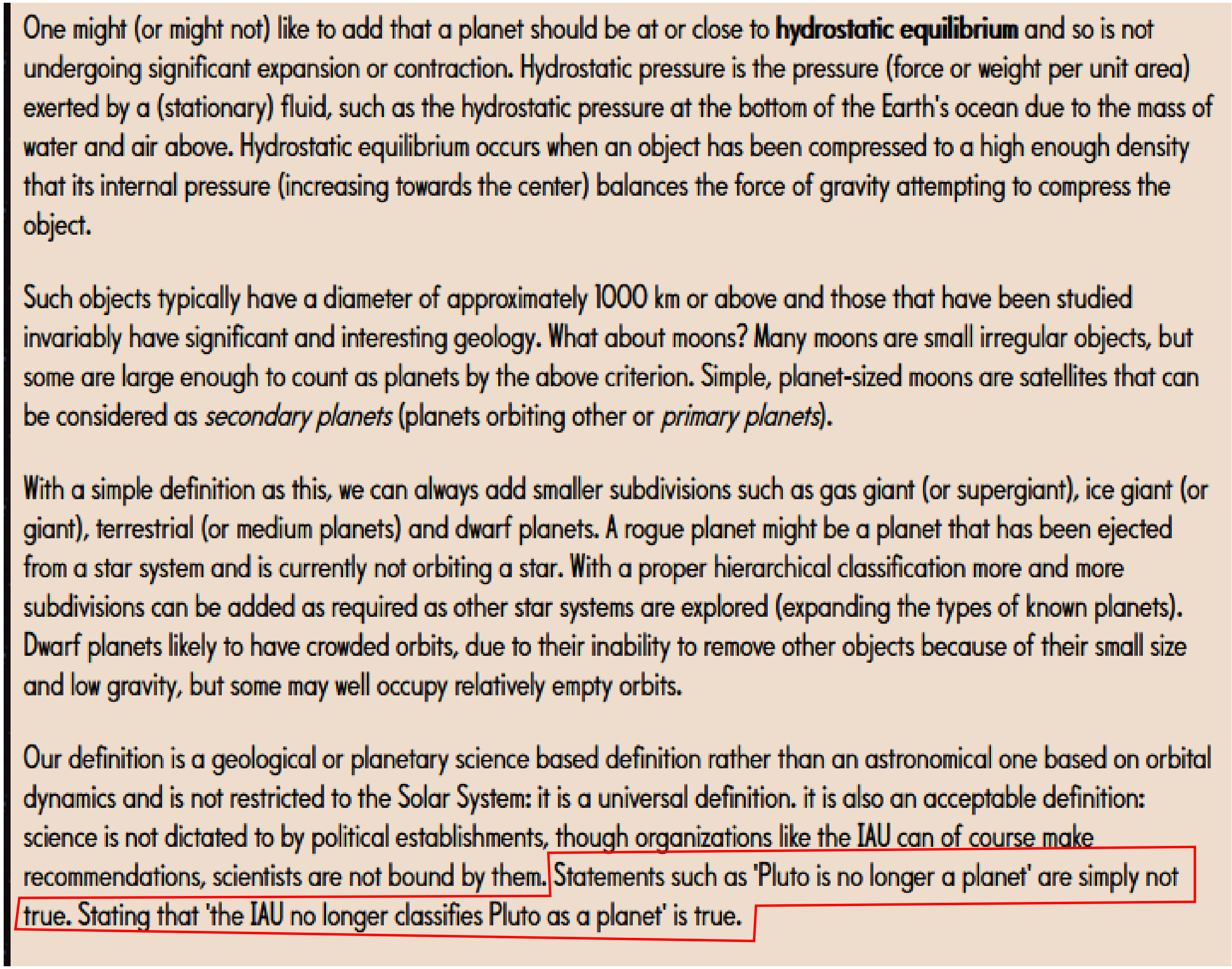
Again, a solar-centric definition. It is also something of a semantic anomaly: a 'dwarf planet' is not a 'planet' apparently. I prefer hierarchical definitions, for example, a Holm Oak is, like a Pedunculate Oak, a species of oak and therefore in the genus *Quercus*.

I prefer a definition that is *not* solar-centric and which is not based on orbital dynamics but based on the fundamental physical properties of the object itself (after all, this is how stars are classified). I define a planet as follows:

> *A planet is an object that has pulled itself into a spheroid due to its self-gravity but is not massive enough to undergo nuclear fission.*

#7 - I took this screenshot from:

https://www.cronodon.com/PlanetTech/solar-system.html



One might (or might not) like to add that a planet should be at or close to **hydrostatic equilibrium** and so is not undergoing significant expansion or contraction. Hydrostatic pressure is the pressure (force or weight per unit area) exerted by a (stationary) fluid, such as the hydrostatic pressure at the bottom of the Earth's ocean due to the mass of water and air above. Hydrostatic equilibrium occurs when an object has been compressed to a high enough density that its internal pressure (increasing towards the center) balances the force of gravity attempting to compress the object.

Such objects typically have a diameter of approximately 1000 km or above and those that have been studied invariably have significant and interesting geology. What about moons? Many moons are small irregular objects, but some are large enough to count as planets by the above criterion. Simple, planet-sized moons are satellites that can be considered as *secondary planets* (planets orbiting other or *primary planets*).

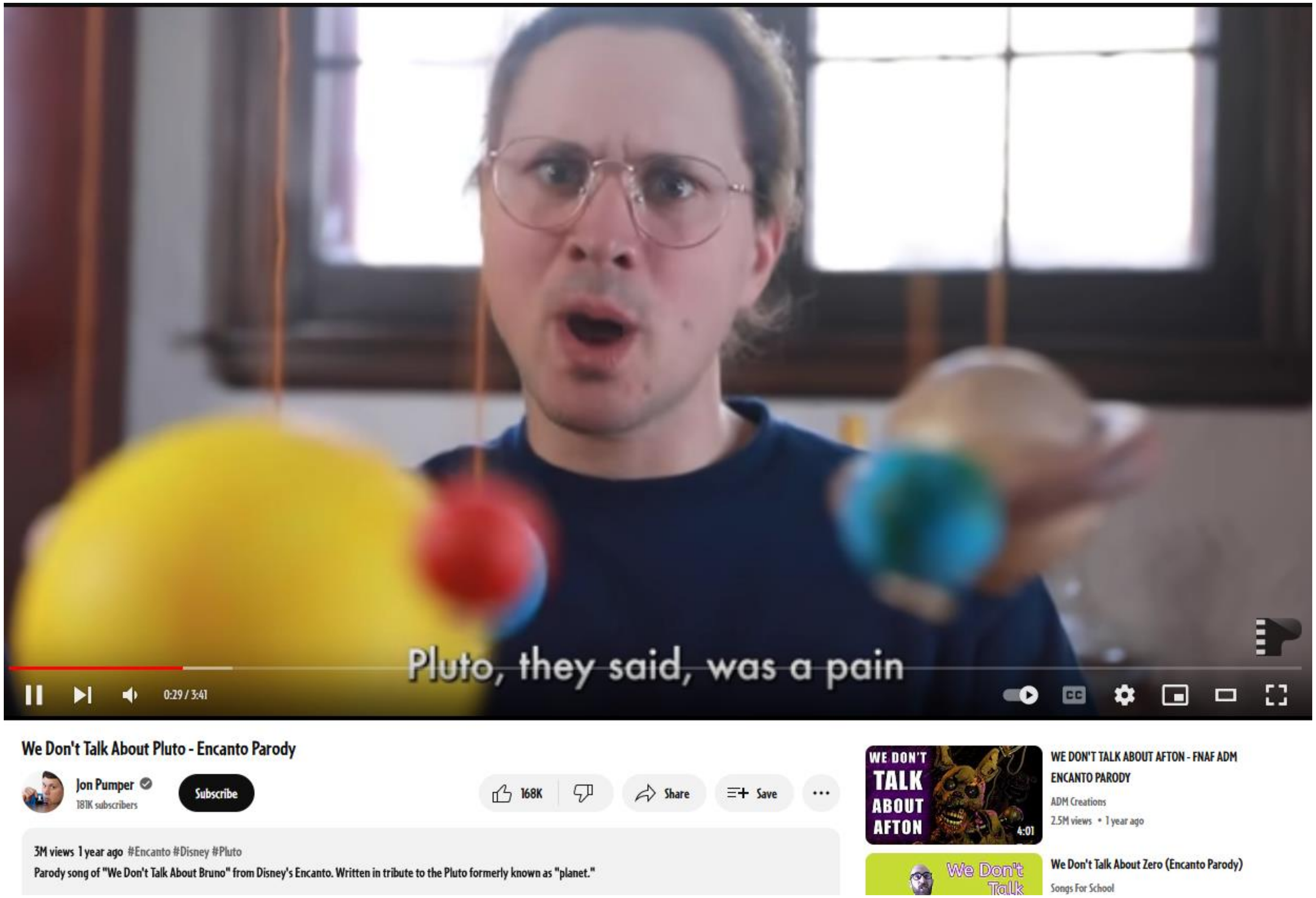
With a simple definition as this, we can always add smaller subdivisions such as gas giant (or supergiant), ice giant (or giant), terrestrial (or medium planets) and dwarf planets. A rogue planet might be a planet that has been ejected from a star system and is currently not orbiting a star. With a proper hierarchical classification more and more subdivisions can be added as required as other star systems are explored (expanding the types of known planets). Dwarf planets likely to have crowded orbits, due to their inability to remove other objects because of their small size and low gravity, but some may well occupy relatively empty orbits.

Our definition is a geological or planetary science based definition rather than an astronomical one based on orbital dynamics and is not restricted to the Solar System: it is a universal definition. it is also an acceptable definition: science is not dictated to by political establishments, though organizations like the IAU can of course make recommendations, scientists are not bound by them. Statements such as 'Pluto is no longer a planet' are simply not true. Stating that 'the IAU no longer classifies Pluto as a planet' is true.

Well said!

#8 - I took this screenshot from:

https://youtube.com/watch?v=YJPHK5NNtpQ&feature=share



Pluto, they said, was a pain

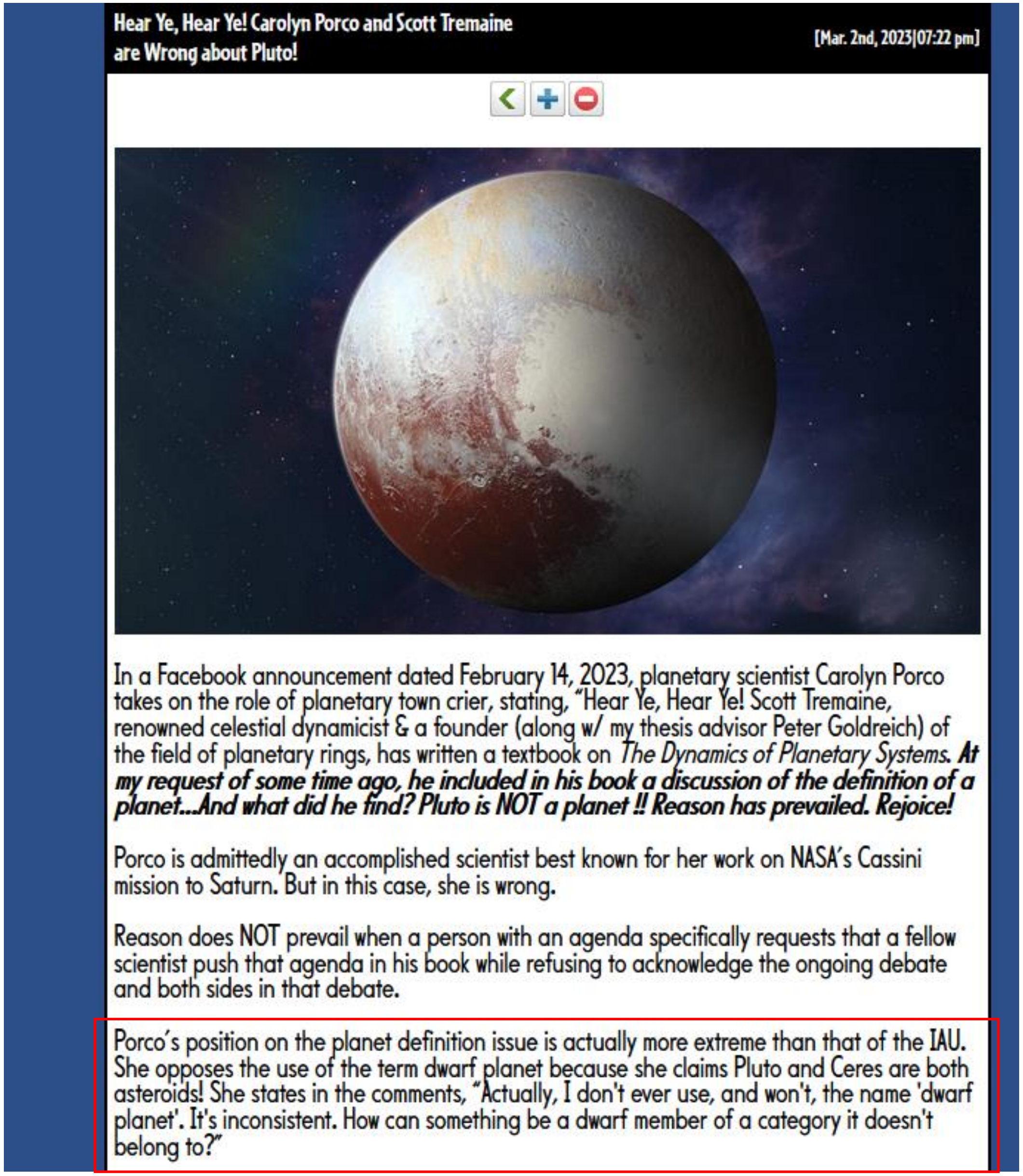
We Don't Talk About Pluto - Encanto Parody

3M views 1 year ago #Encanto #Disney #Pluto
Parody song of "We Don't Talk About Bruno" from Disney's Encanto. Written in tribute to the Pluto formerly known as "planet."

"We Don't Talk About Pluto" we used to not talk about Pluto. Now we do, again. This parody might be out to date one day.

#9 - I took this screenshot from:

https://laurele.livejournal.com/124021.html



Hear Ye, Hear Ye! Carolyn Porco and Scott Tremaine are Wrong about Pluto!

[Mar. 2nd, 2023|07:22 pm]

In a Facebook announcement dated February 14, 2023, planetary scientist Carolyn Porco takes on the role of planetary town crier, stating, "Hear Ye, Hear Ye! Scott Tremaine, renowned celestial dynamicist & a founder (along w/ my thesis advisor Peter Goldreich) of the field of planetary rings, has written a textbook on *The Dynamics of Planetary Systems.* ***At my request of some time ago, he included in his book a discussion of the definition of a planet...And what did he find? Pluto is NOT a planet !! Reason has prevailed. Rejoice!***

Porco is admittedly an accomplished scientist best known for her work on NASA's Cassini mission to Saturn. But in this case, she is wrong.

Reason does NOT prevail when a person with an agenda specifically requests that a fellow scientist push that agenda in his book while refusing to acknowledge the ongoing debate and both sides in that debate.

Porco's position on the planet definition issue is actually more extreme than that of the IAU. She opposes the use of the term dwarf planet because she claims Pluto and Ceres are both asteroids! She states in the comments, "Actually, I don't ever use, and won't, the name 'dwarf planet'. It's inconsistent. How can something be a dwarf member of a category it doesn't belong to?"

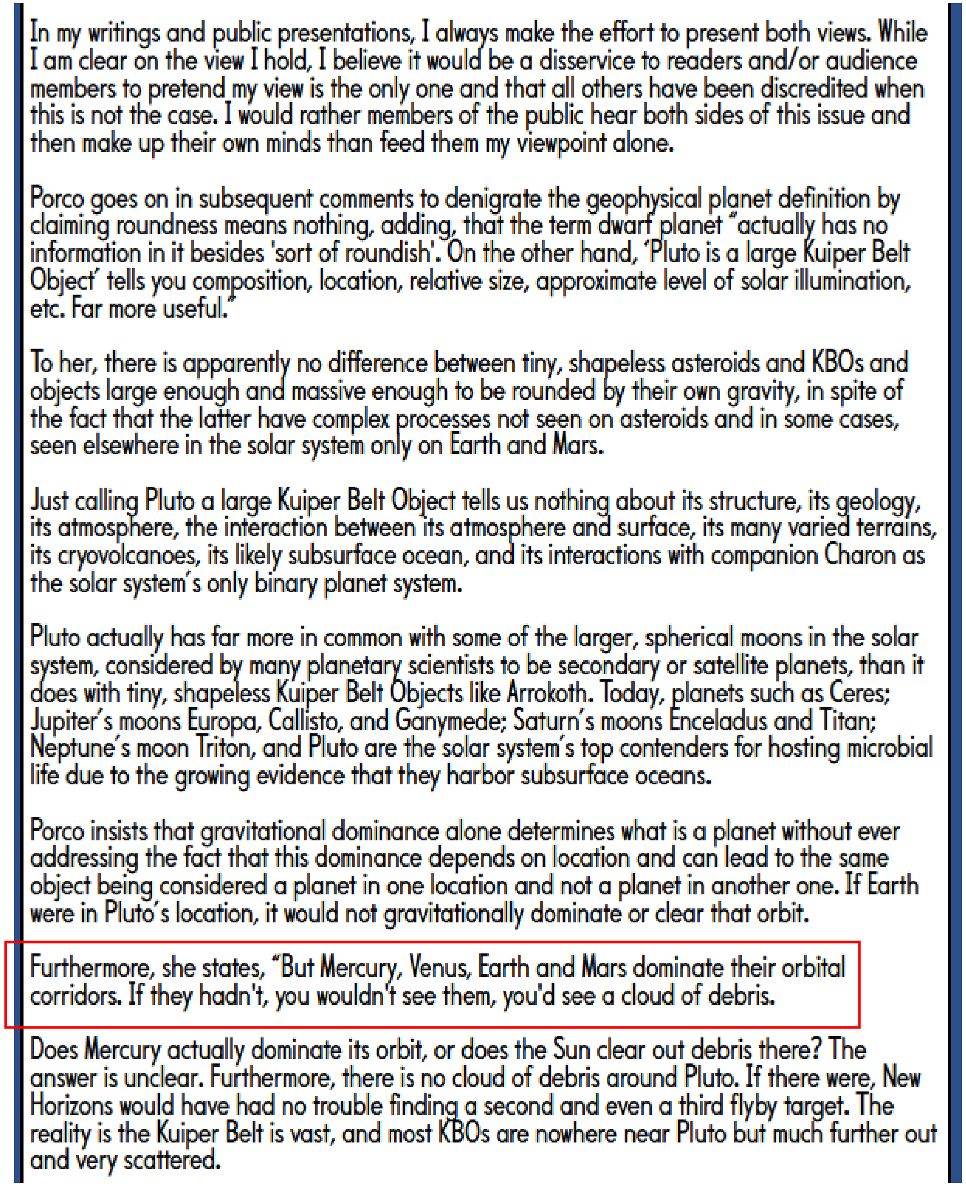
Carolyn Porco, who is admittedly a qualified scientist known for her work on NASA's Cassini Mission, called Pluto an asteroid. Ceres, of course, was considered an asteroid, but it turned out to be round.

This is a screenshot from Laurel Kornfeld's blog.

How can Pluto be an asteroid when it's round and pulling itself into a sphere? It's way too large! It has an atmosphere, it has the characteristics of a planet, and it has nothing to do with asteroids.

#9 - I took this screenshot from:

https://laurele.livejournal.com/124021.html



In my writings and public presentations, I always make the effort to present both views. While I am clear on the view I hold, I believe it would be a disservice to readers and/or audience members to pretend my view is the only one and that all others have been discredited when this is not the case. I would rather members of the public hear both sides of this issue and then make up their own minds than feed them my viewpoint alone.

Porco goes on in subsequent comments to denigrate the geophysical planet definition by claiming roundness means nothing, adding, that the term dwarf planet "actually has no information in it besides 'sort of roundish'. On the other hand, 'Pluto is a large Kuiper Belt Object' tells you composition, location, relative size, approximate level of solar illumination, etc. Far more useful."

To her, there is apparently no difference between tiny, shapeless asteroids and KBOs and objects large enough and massive enough to be rounded by their own gravity, in spite of the fact that the latter have complex processes not seen on asteroids and in some cases, seen elsewhere in the solar system only on Earth and Mars.

Just calling Pluto a large Kuiper Belt Object tells us nothing about its structure, its geology, its atmosphere, the interaction between its atmosphere and surface, its many varied terrains, its cryovolcanoes, its likely subsurface ocean, and its interactions with companion Charon as the solar system's only binary planet system.

Pluto actually has far more in common with some of the larger, spherical moons in the solar system, considered by many planetary scientists to be secondary or satellite planets, than it does with tiny, shapeless Kuiper Belt Objects like Arrokoth. Today, planets such as Ceres; Jupiter's moons Europa, Callisto, and Ganymede; Saturn's moons Enceladus and Titan; Neptune's moon Triton, and Pluto are the solar system's top contenders for hosting microbial life due to the growing evidence that they harbor subsurface oceans.

Porco insists that gravitational dominance alone determines what is a planet without ever addressing the fact that this dominance depends on location and can lead to the same object being considered a planet in one location and not a planet in another one. If Earth were in Pluto's location, it would not gravitationally dominate or clear that orbit.

Furthermore, she states, "But Mercury, Venus, Earth and Mars dominate their orbital corridors. If they hadn't, you wouldn't see them, you'd see a cloud of debris.

Does Mercury actually dominate its orbit, or does the Sun clear out debris there? The answer is unclear. Furthermore, there is no cloud of debris around Pluto. If there were, New Horizons would have had no trouble finding a second and even a third flyby target. The reality is the Kuiper Belt is vast, and most KBOs are nowhere near Pluto but much further out and very scattered.

Once again, I don't think Mercury actually dominates its orbit, but that reason is definitely unclear. Again, that's probably why Mercury and Venus have no moons!

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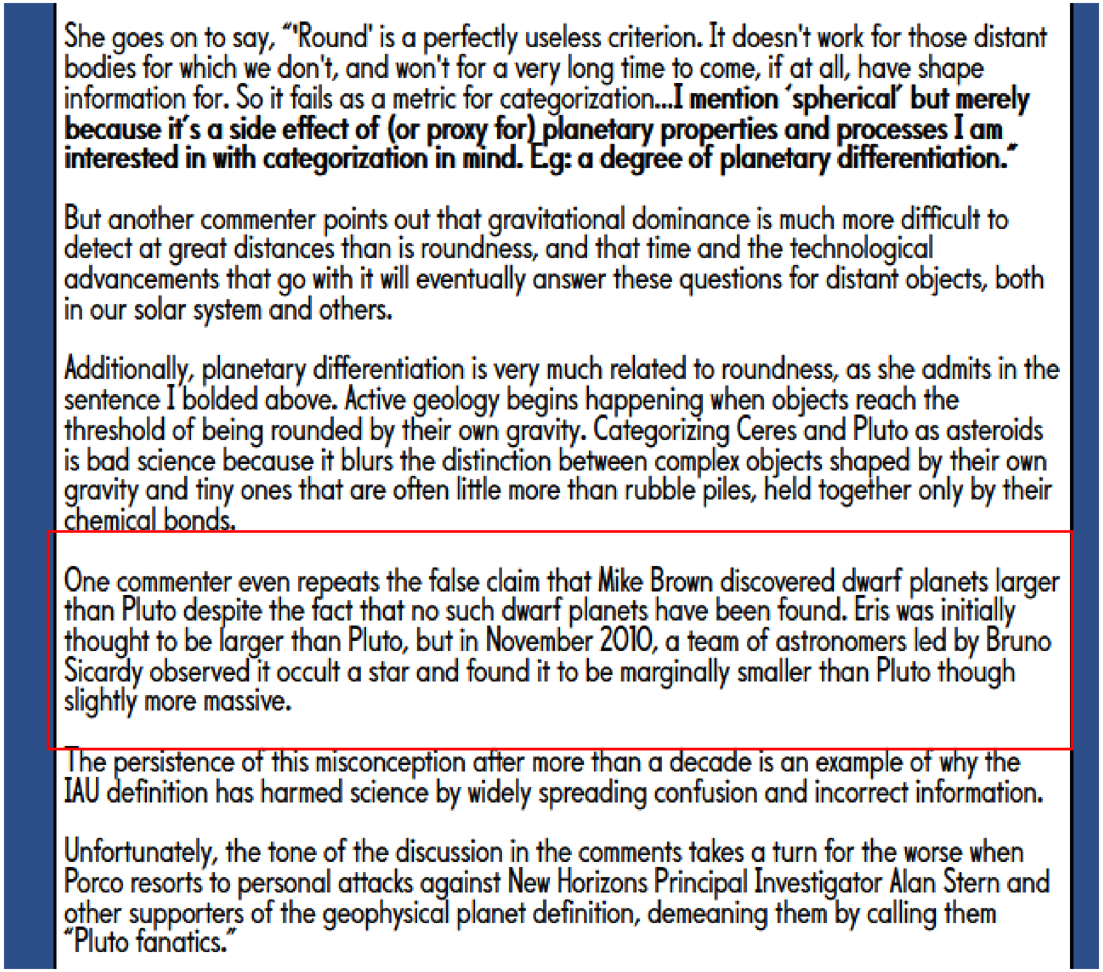

She goes on to say, "'Round' is a perfectly useless criterion. It doesn't work for those distant bodies for which we don't, and won't for a very long time to come, if at all, have shape information for. So it fails as a metric for categorization...**I mention 'spherical' but merely because it's a side effect of (or proxy for) planetary properties and processes I am interested in with categorization in mind. E.g: a degree of planetary differentiation."**

But another commenter points out that gravitational dominance is much more difficult to detect at great distances than is roundness, and that time and the technological advancements that go with it will eventually answer these questions for distant objects, both in our solar system and others.

Additionally, planetary differentiation is very much related to roundness, as she admits in the sentence I bolded above. Active geology begins happening when objects reach the threshold of being rounded by their own gravity. Categorizing Ceres and Pluto as asteroids is bad science because it blurs the distinction between complex objects shaped by their own gravity and tiny ones that are often little more than rubble piles, held together only by their chemical bonds.

One commenter even repeats the false claim that Mike Brown discovered dwarf planets larger than Pluto despite the fact that no such dwarf planets have been found. Eris was initially thought to be larger than Pluto, but in November 2010, a team of astronomers led by Bruno Sicardy observed it occult a star and found it to be marginally smaller than Pluto though slightly more massive.

The persistence of this misconception after more than a decade is an example of why the IAU definition has harmed science by widely spreading confusion and incorrect information.

Unfortunately, the tone of the discussion in the comments takes a turn for the worse when Porco resorts to personal attacks against New Horizons Principal Investigator Alan Stern and other supporters of the geophysical planet definition, demeaning them by calling them "Pluto fanatics."

Mike Brown was wrong about Eris' size compared to Pluto. He thought that Eris was the biggest dwarf planet in the Solar System, but then in the 2010s it turned out to be slightly smaller, though slightly more massive.

#9 - I took this screenshot from:

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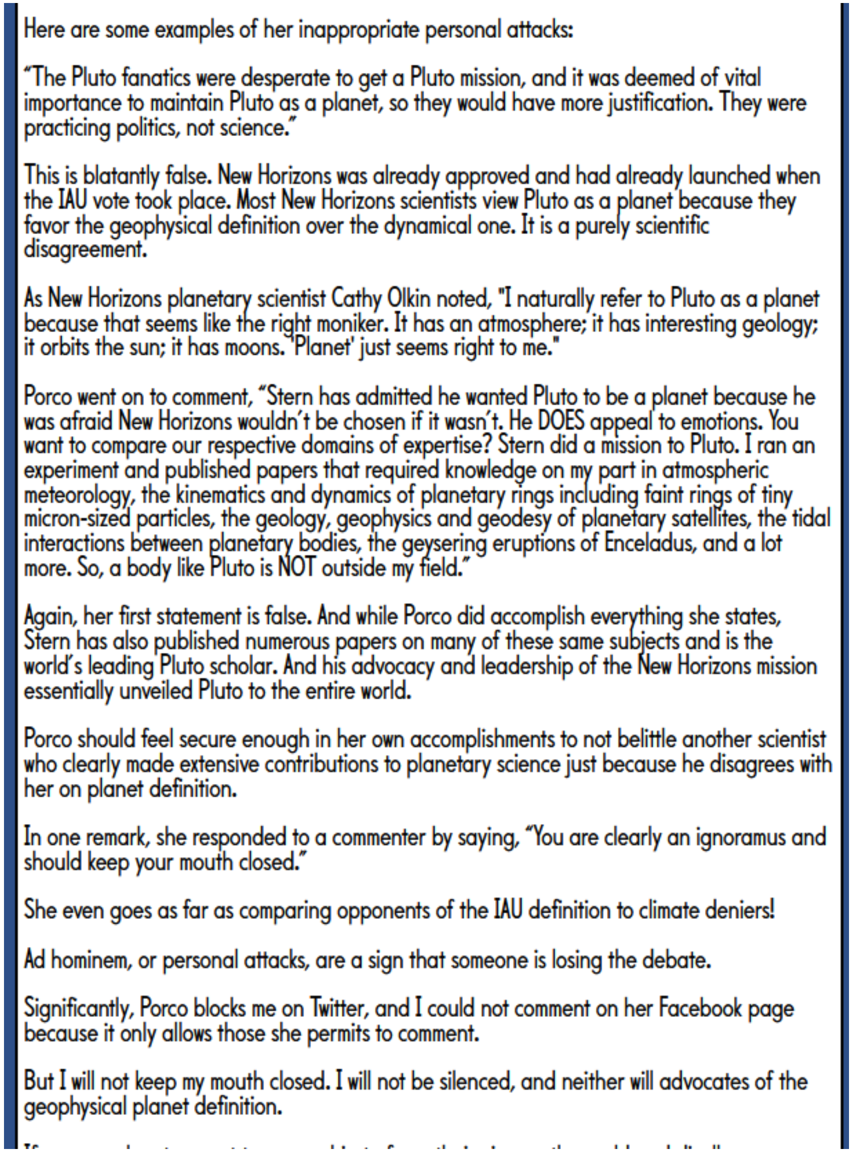


Here are some examples of her inappropriate personal attacks:

"The Pluto fanatics were desperate to get a Pluto mission, and it was deemed of vital importance to maintain Pluto as a planet, so they would have more justification. They were practicing politics, not science."

This is blatantly false. New Horizons was already approved and had already launched when the IAU vote took place. Most New Horizons scientists view Pluto as a planet because they favor the geophysical definition over the dynamical one. It is a purely scientific disagreement.

As New Horizons planetary scientist Cathy Olkin noted, "I naturally refer to Pluto as a planet because that seems like the right moniker. It has an atmosphere; it has interesting geology; it orbits the sun; it has moons. 'Planet' just seems right to me."

Porco went on to comment, "Stern has admitted he wanted Pluto to be a planet because he was afraid New Horizons wouldn't be chosen if it wasn't. He DOES appeal to emotions. You want to compare our respective domains of expertise? Stern did a mission to Pluto. I ran an experiment and published papers that required knowledge on my part in atmospheric meteorology, the kinematics and dynamics of planetary rings including faint rings of tiny micron-sized particles, the geology, geophysics and geodesy of planetary satellites, the tidal interactions between planetary bodies, the geysering eruptions of Enceladus, and a lot more. So, a body like Pluto is NOT outside my field."

Again, her first statement is false. And while Porco did accomplish everything she states, Stern has also published numerous papers on many of these same subjects and is the world's leading Pluto scholar. And his advocacy and leadership of the New Horizons mission essentially unveiled Pluto to the entire world.

Porco should feel secure enough in her own accomplishments to not belittle another scientist who clearly made extensive contributions to planetary science just because he disagrees with her on planet definition.

In one remark, she responded to a commenter by saying, "You are clearly an ignoramus and should keep your mouth closed."

She even goes as far as comparing opponents of the IAU definition to climate deniers!

Ad hominem, or personal attacks, are a sign that someone is losing the debate.

Significantly, Porco blocks me on Twitter, and I could not comment on her Facebook page because it only allows those she permits to comment.

But I will not keep my mouth closed. I will not be silenced, and neither will advocates of the geophysical planet definition.

Kornfeld stated that Porco was attacking planetary scientists and GPD advocates and started to use insults against a commenter on her post, and then she told them to stop talking. This states that she is losing the argument.

Kornfeld also stated that Porco also called GPD advocates as "Pluto fanatics" and compared opponents of the IAU definition to climate change deniers!

She also blocked Kornfeld on Twitter. This sounds really unprofessional.

#10 - Some of Mike Brown's statements

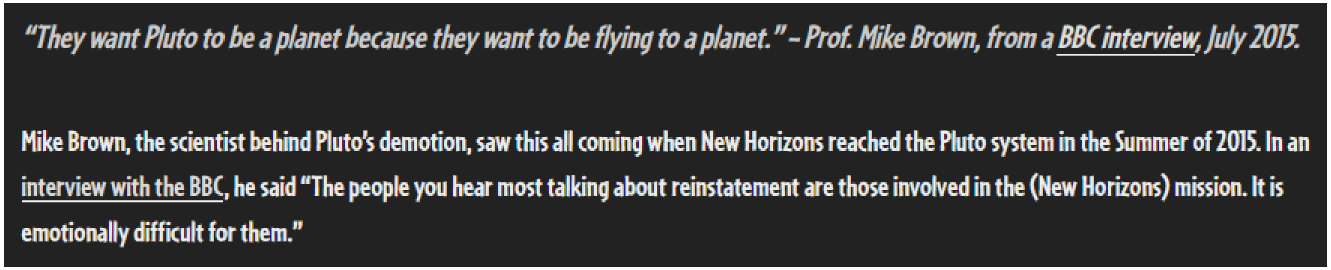
One of the sources come from: https://www.universetoday.com/134519/get-ready-100-planet-solar-system/

I remember seeing a statement that Mike Brown said. If I remember correctly, he said "Pluto is not a planet, and it never has been a planet! As for those who learned about the statement that Pluto was a planet, you are all wrong. It can never dominate its orbit" or something like that.

If I can find the article where I found that statement, I will send it to you, or if somebody can provide me a link to that, please send it to me.

My comment: no comment.

But look at this one:



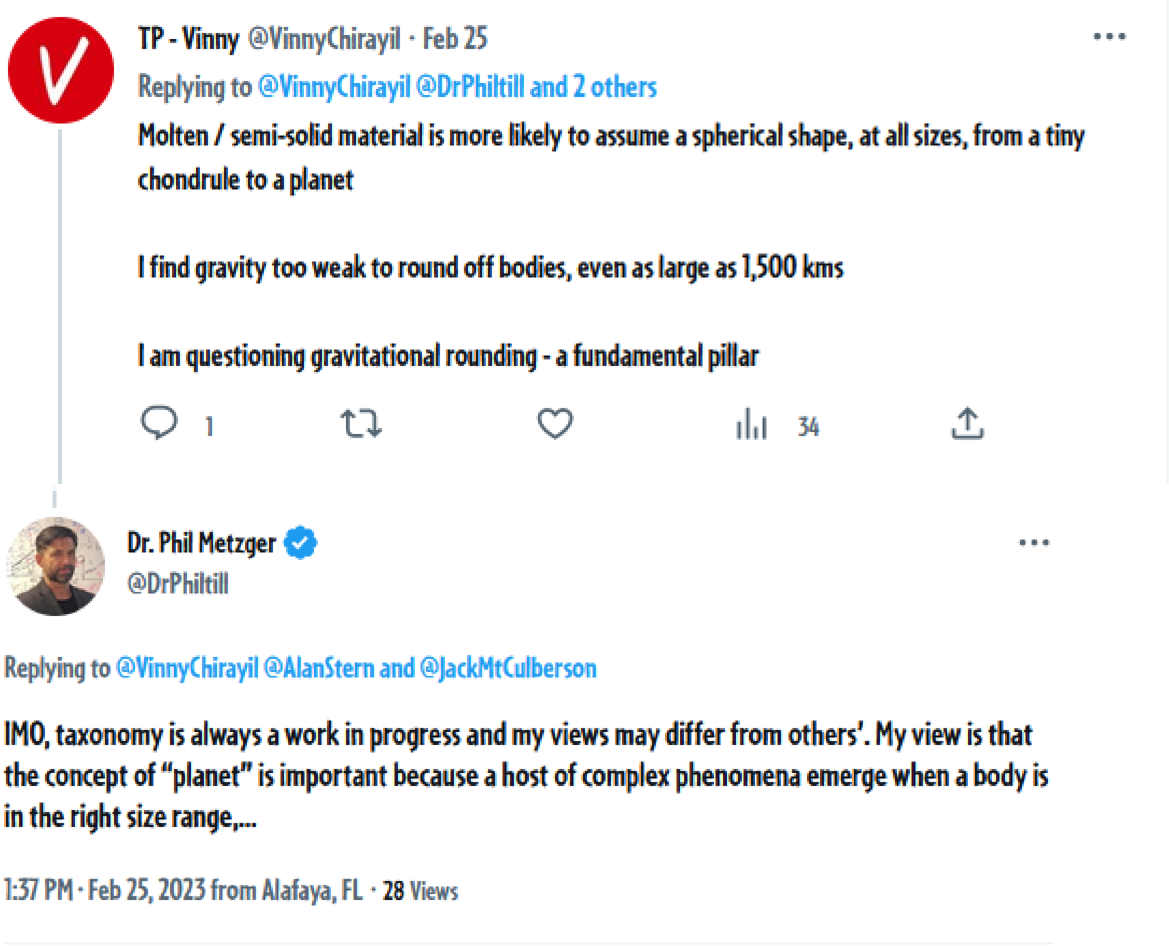
"They want Pluto to be a planet because they want to be flying to a planet." – Prof. Mike Brown, from a BBC interview, July 2015.

Mike Brown, the scientist behind Pluto's demotion, saw this all coming when New Horizons reached the Pluto system in the Summer of 2015. In an interview with the BBC, he said "The people you hear most talking about reinstatement are those involved in the (New Horizons) mission. It is emotionally difficult for them."

My comment: How cute of you, Brown! So you're saying it is emotionally difficult for them just because they wanted to reinstate Pluto as a planet? Maybe you might be ready for the big news: what you said seems really unscientific.

#11 - More of Dr. Phil Metzger's statements

Here's some of what Metzger stated in one of my posts on Twitter. This is a really long explanation, so here it is. He was explaining these to a science critic that replied on one of my first Twitter posts. When something is unclear, you may add some clarification like what the critic did. Here it is:



TP - Vinny @VinnyChirayil · Feb 25

Replying to @VinnyChirayil @DrPhiltill and 2 others

Molten / semi-solid material is more likely to assume a spherical shape, at all sizes, from a tiny chondrule to a planet

I find gravity too weak to round off bodies, even as large as 1,500 kms

I am questioning gravitational rounding - a fundamental pillar

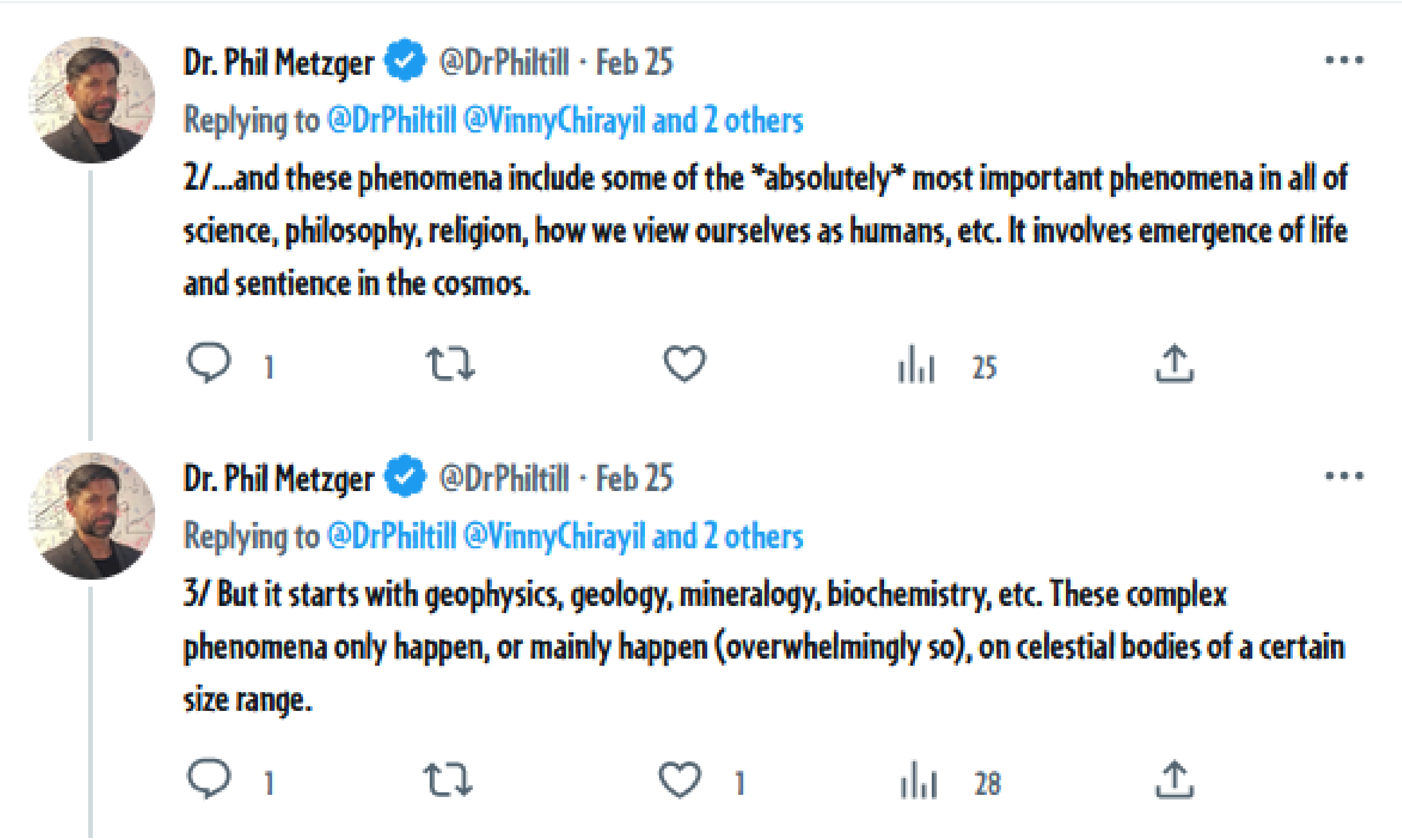
Dr. Phil Metzger
@DrPhiltill

Replying to @VinnyChirayil @AlanStern and @JackMtCulberson

IMO, taxonomy is always a work in progress and my views may differ from others'. My view is that the concept of "planet" is important because a host of complex phenomena emerge when a body is in the right size range,...

1:37 PM · Feb 25, 2023 from Alafaya, FL · 28 Views

#11 - More of Dr. Phil Metzger's statements



Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

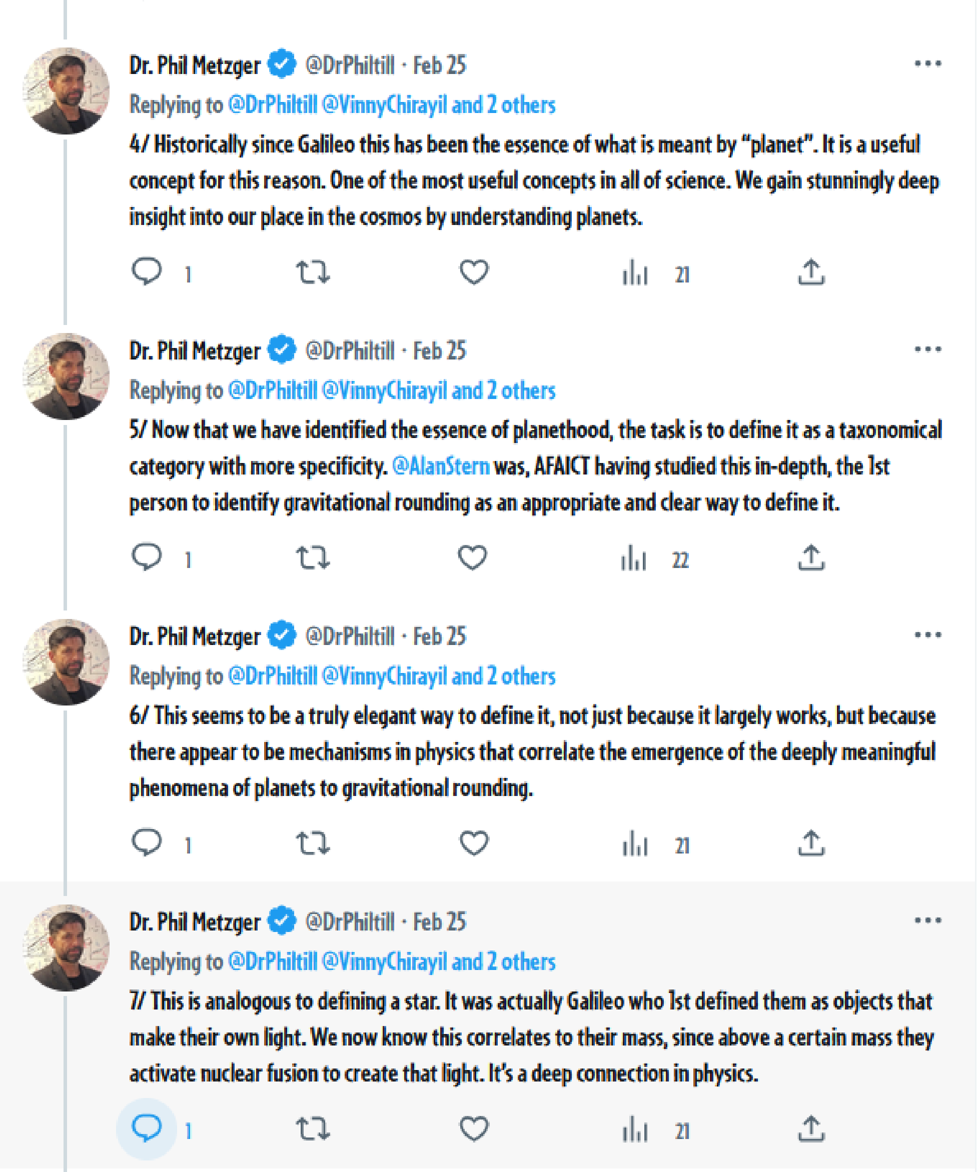
2/...and these phenomena include some of the *absolutely* most important phenomena in all of science, philosophy, religion, how we view ourselves as humans, etc. It involves emergence of life and sentience in the cosmos.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

3/ But it starts with geophysics, geology, mineralogy, biochemistry, etc. These complex phenomena only happen, or mainly happen (overwhelmingly so), on celestial bodies of a certain size range.

#11 - More of Dr. Phil Metzger's statements



Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

4/ Historically since Galileo this has been the essence of what is meant by "planet". It is a useful concept for this reason. One of the most useful concepts in all of science. We gain stunningly deep insight into our place in the cosmos by understanding planets.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

5/ Now that we have identified the essence of planethood, the task is to define it as a taxonomical category with more specificity. @AlanStern was, AFAICT having studied this in-depth, the 1st person to identify gravitational rounding as an appropriate and clear way to define it.

Dr. Phil Metzger @DrPhiltill · Feb 25

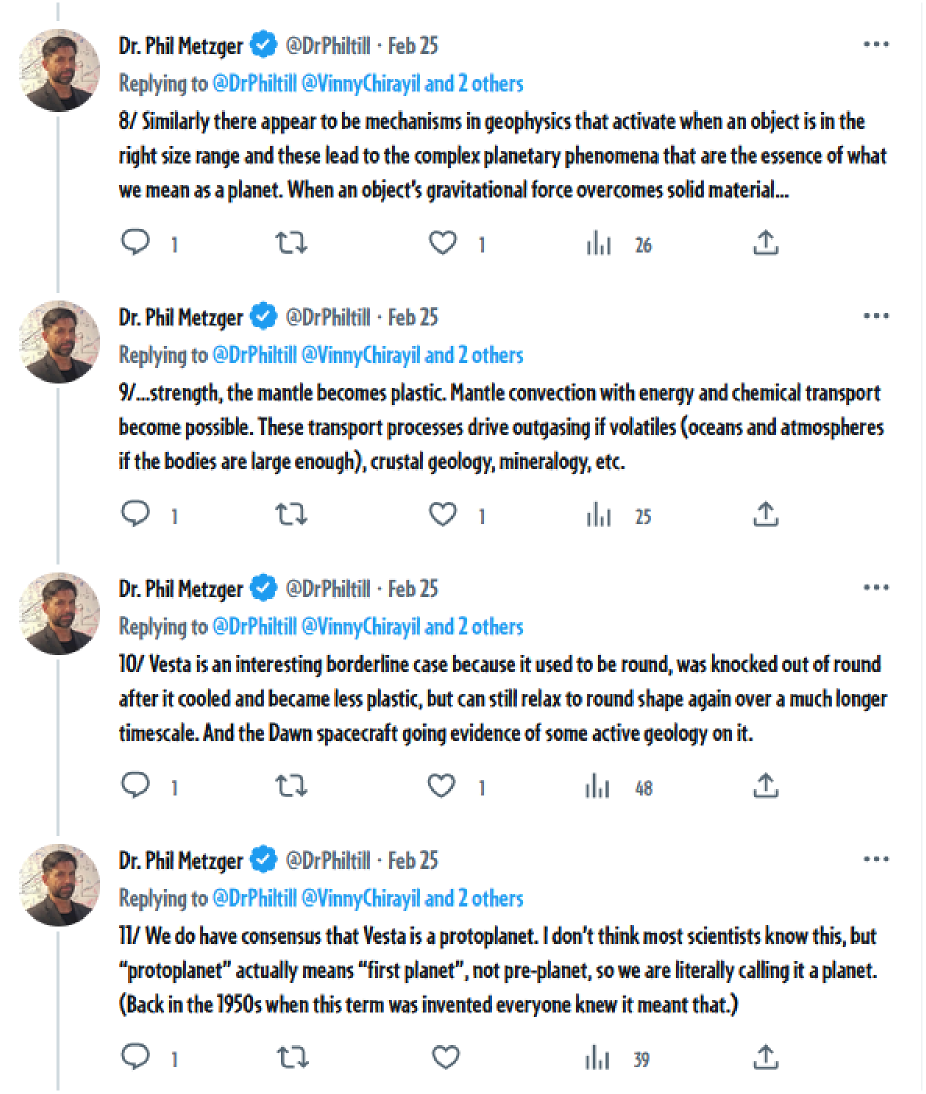
Replying to @DrPhiltill @VinnyChirayil and 2 others

6/ This seems to be a truly elegant way to define it, not just because it largely works, but because there appear to be mechanisms in physics that correlate the emergence of the deeply meaningful phenomena of planets to gravitational rounding.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

7/ This is analogous to defining a star. It was actually Galileo who 1st defined them as objects that make their own light. We now know this correlates to their mass, since above a certain mass they activate nuclear fusion to create that light. It's a deep connection in physics.



Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

8/ Similarly there appear to be mechanisms in geophysics that activate when an object is in the right size range and these lead to the complex planetary phenomena that are the essence of what we mean as a planet. When an object's gravitational force overcomes solid material...

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

9/...strength, the mantle becomes plastic. Mantle convection with energy and chemical transport become possible. These transport processes drive outgasing if volatiles (oceans and atmospheres if the bodies are large enough), crustal geology, mineralogy, etc.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

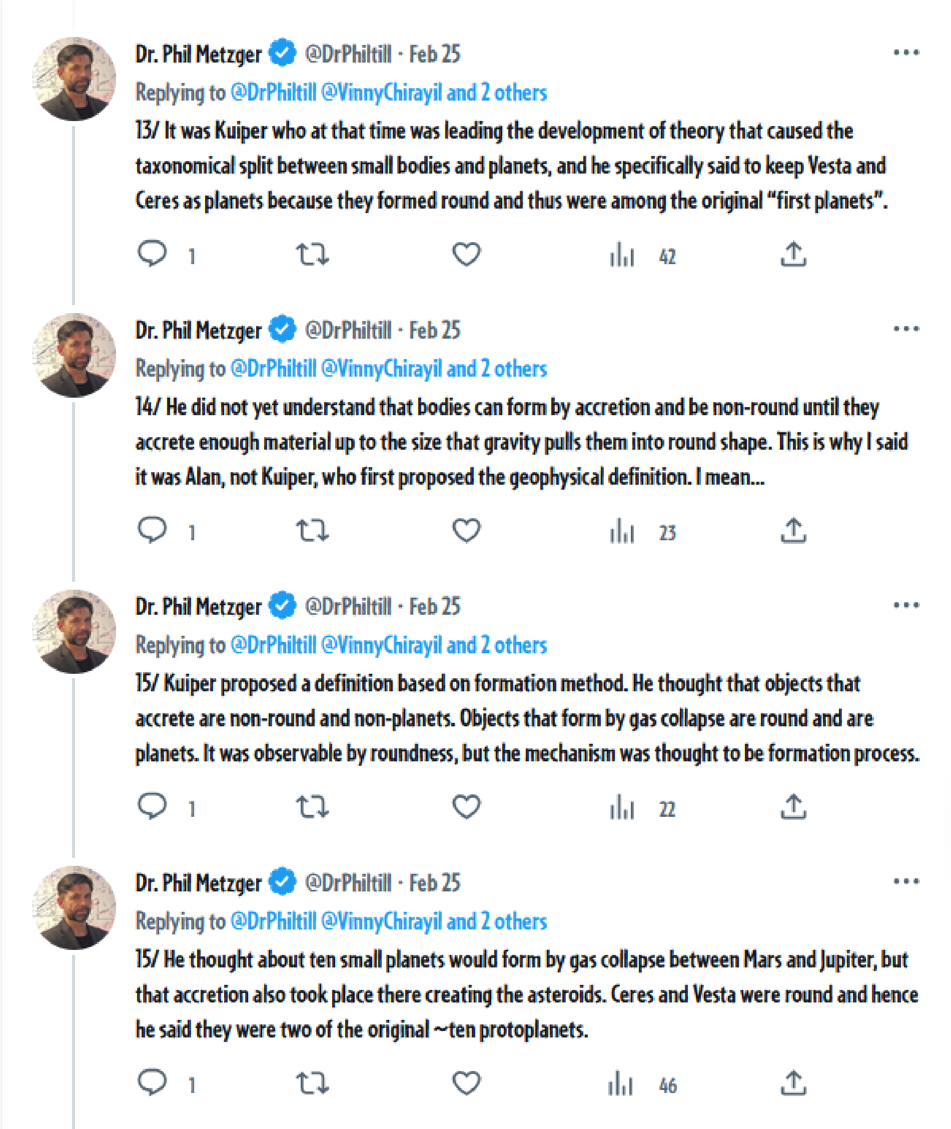
10/ Vesta is an interesting borderline case because it used to be round, was knocked out of round after it cooled and became less plastic, but can still relax to round shape again over a much longer timescale. And the Dawn spacecraft going evidence of some active geology on it.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

11/ We do have consensus that Vesta is a protoplanet. I don't think most scientists know this, but "protoplanet" actually means "first planet", not pre-planet, so we are literally calling it a planet. (Back in the 1950s when this term was invented everyone knew it meant that.)

#11 - More of Dr. Phil Metzger's statements



Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

13/ It was Kuiper who at that time was leading the development of theory that caused the taxonomical split between small bodies and planets, and he specifically said to keep Vesta and Ceres as planets because they formed round and thus were among the original "first planets".

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

14/ He did not yet understand that bodies can form by accretion and be non-round until they accrete enough material up to the size that gravity pulls them into round shape. This is why I said it was Alan, not Kuiper, who first proposed the geophysical definition. I mean...

Dr. Phil Metzger @DrPhiltill · Feb 25

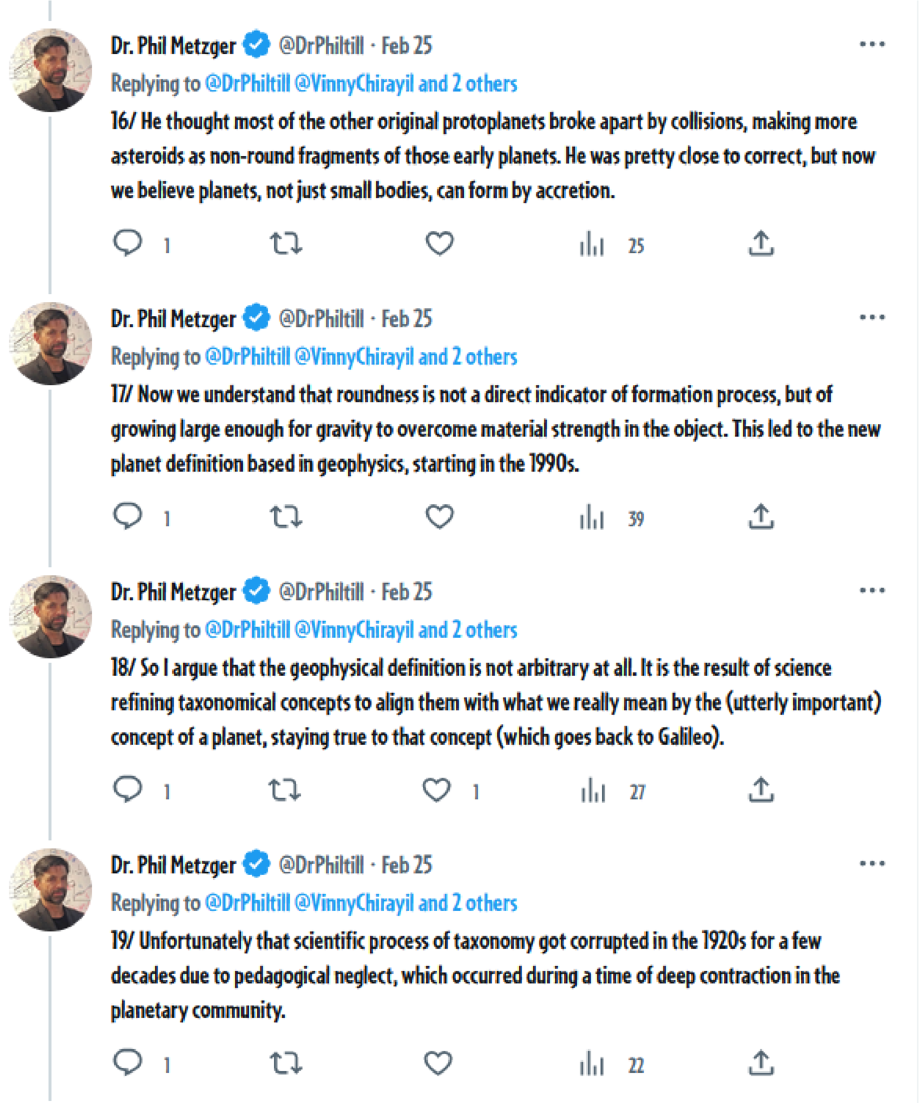
Replying to @DrPhiltill @VinnyChirayil and 2 others

15/ Kuiper proposed a definition based on formation method. He thought that objects that accrete are non-round and non-planets. Objects that form by gas collapse are round and are planets. It was observable by roundness, but the mechanism was thought to be formation process.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

15/ He thought about ten small planets would form by gas collapse between Mars and Jupiter, but that accretion also took place there creating the asteroids. Ceres and Vesta were round and hence he said they were two of the original ~ten protoplanets.



Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

16/ He thought most of the other original protoplanets broke apart by collisions, making more asteroids as non-round fragments of those early planets. He was pretty close to correct, but now we believe planets, not just small bodies, can form by accretion.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

17/ Now we understand that roundness is not a direct indicator of formation process, but of growing large enough for gravity to overcome material strength in the object. This led to the new planet definition based in geophysics, starting in the 1990s.

Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

18/ So I argue that the geophysical definition is not arbitrary at all. It is the result of science refining taxonomical concepts to align them with what we really mean by the (utterly important) concept of a planet, staying true to that concept (which goes back to Galileo).

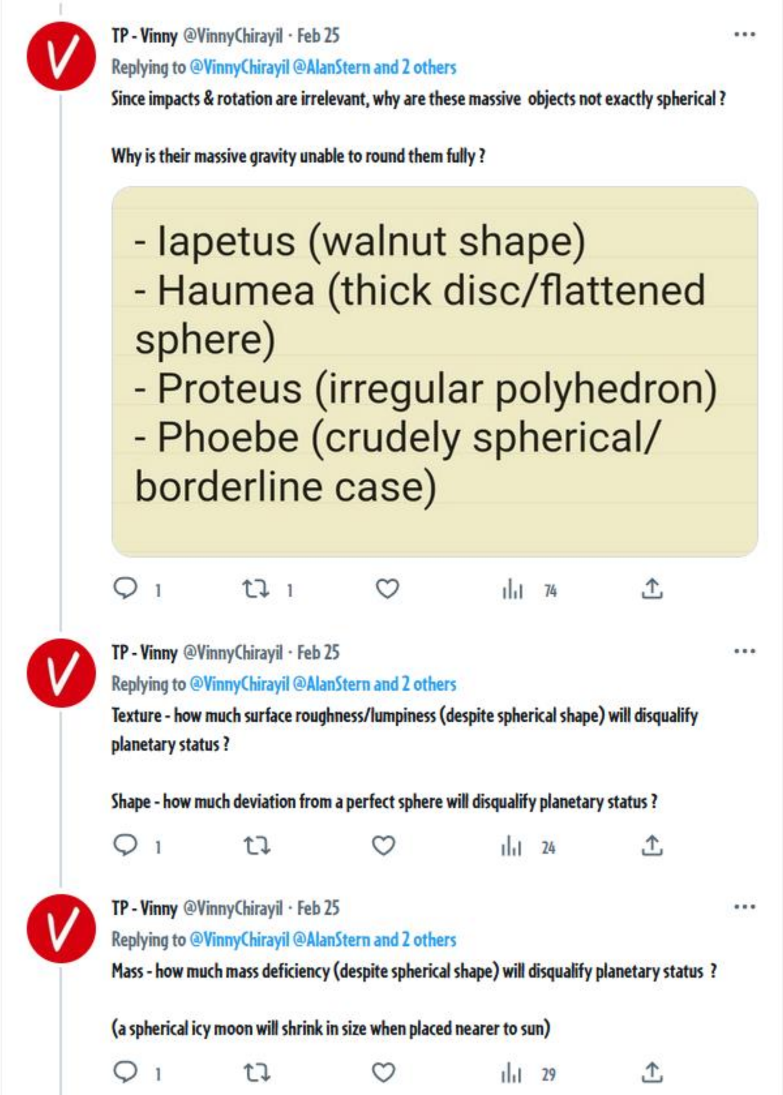
Dr. Phil Metzger @DrPhiltill · Feb 25

Replying to @DrPhiltill @VinnyChirayil and 2 others

19/ Unfortunately that scientific process of taxonomy got corrupted in the 1920s for a few decades due to pedagogical neglect, which occurred during a time of deep contraction in the planetary community.

#12 - Even more of Dr. Phil Metzger's statements

The same science critic asked more questions to Metzger. As the critic asked, how much gravity is required to fully make them round? How much roughness or lumpiness does the texture disqualify planetary status? How much mass will disqualify an object from being a planet? And more questions!



TP - Vinny @VinnyChirayil · Feb 25
Replying to @VinnyChirayil @AlanStern and 2 others

Since impacts & rotation are irrelevant, why are these massive objects not exactly spherical ?

Why is their massive gravity unable to round them fully ?

- Iapetus (walnut shape)
- Haumea (thick disc/flattened sphere)
- Proteus (irregular polyhedron)
- Phoebe (crudely spherical/ borderline case)

TP - Vinny @VinnyChirayil · Feb 25
Replying to @VinnyChirayil @AlanStern and 2 others

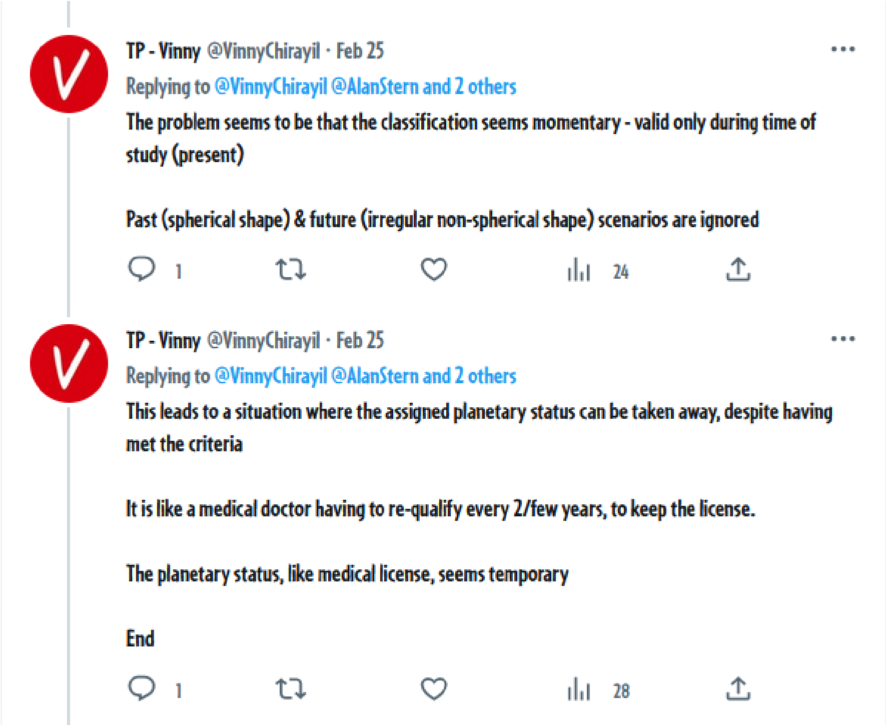
Texture - how much surface roughness/lumpiness (despite spherical shape) will disqualify planetary status ?

Shape - how much deviation from a perfect sphere will disqualify planetary status ?

TP - Vinny @VinnyChirayil · Feb 25
Replying to @VinnyChirayil @AlanStern and 2 others

Mass - how much mass deficiency (despite spherical shape) will disqualify planetary status ?

(a spherical icy moon will shrink in size when placed nearer to sun)



TP - Vinny @VinnyChirayil · Feb 25
Replying to @VinnyChirayil @AlanStern and 2 others

The problem seems to be that the classification seems momentary - valid only during time of study (present)

Past (spherical shape) & future (irregular non-spherical shape) scenarios are ignored

TP - Vinny @VinnyChirayil · Feb 25
Replying to @VinnyChirayil @AlanStern and 2 others

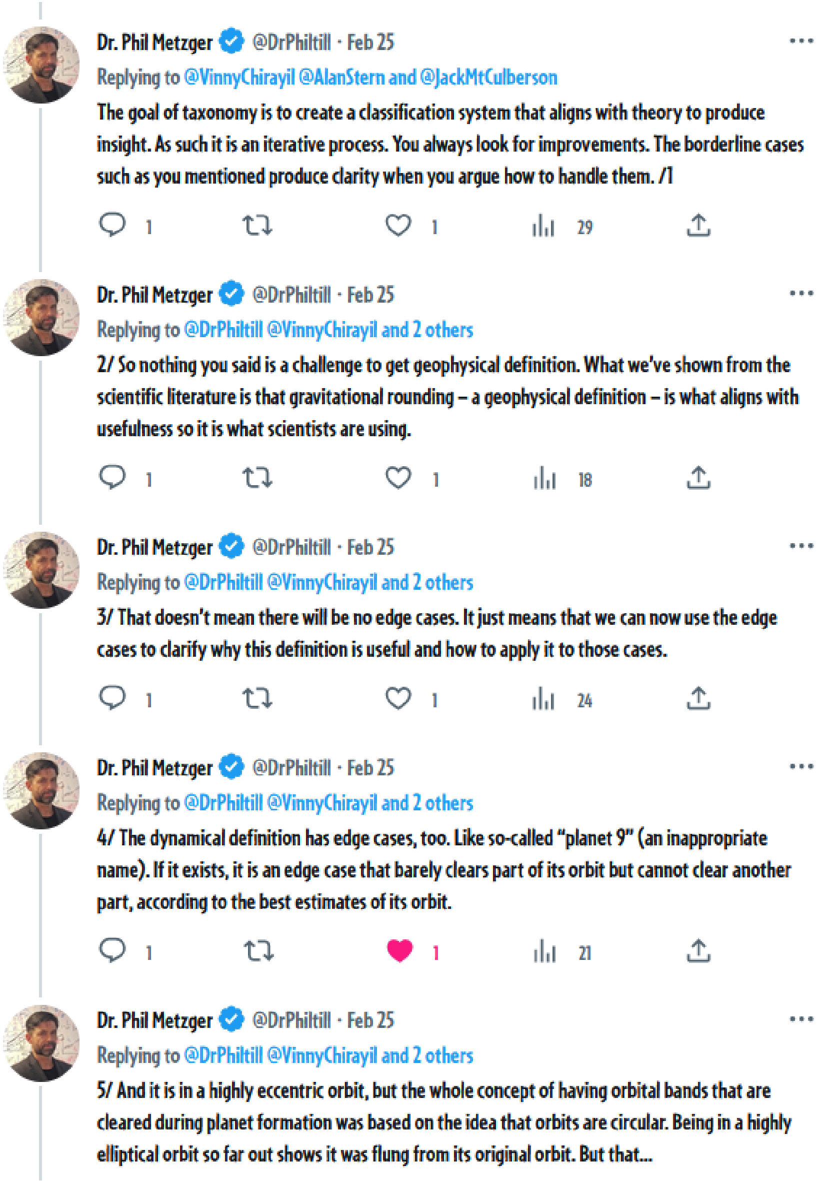
This leads to a situation where the assigned planetary status can be taken away, despite having met the criteria

It is like a medical doctor having to re-qualify every 2/few years, to keep the license.

The planetary status, like medical license, seems temporary

End

#12 - Even more of Dr. Phil Metzger's statements



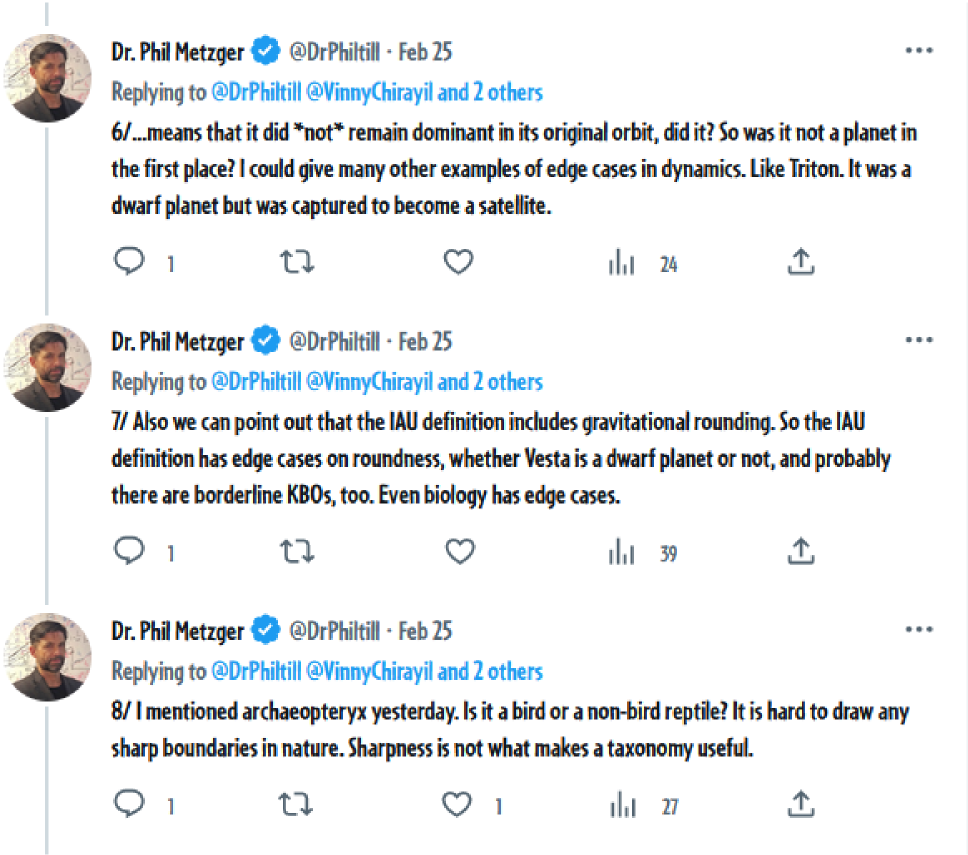
Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @VinnyChirayil @AlanStern and @JackMtCulberson
The goal of taxonomy is to create a classification system that aligns with theory to produce insight. As such it is an iterative process. You always look for improvements. The borderline cases such as you mentioned produce clarity when you argue how to handle them. /1

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
2/ So nothing you said is a challenge to get geophysical definition. What we've shown from the scientific literature is that gravitational rounding – a geophysical definition – is what aligns with usefulness so it is what scientists are using.

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
3/ That doesn't mean there will be no edge cases. It just means that we can now use the edge cases to clarify why this definition is useful and how to apply it to those cases.

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
4/ The dynamical definition has edge cases, too. Like so-called "planet 9" (an inappropriate name). If it exists, it is an edge case that barely clears part of its orbit but cannot clear another part, according to the best estimates of its orbit.

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
5/ And it is in a highly eccentric orbit, but the whole concept of having orbital bands that are cleared during planet formation was based on the idea that orbits are circular. Being in a highly elliptical orbit so far out shows it was flung from its original orbit. But that...



Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
6/...means that it did *not* remain dominant in its original orbit, did it? So was it not a planet in the first place? I could give many other examples of edge cases in dynamics. Like Triton. It was a dwarf planet but was captured to become a satellite.

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
7/ Also we can point out that the IAU definition includes gravitational rounding. So the IAU definition has edge cases on roundness, whether Vesta is a dwarf planet or not, and probably there are borderline KBOs, too. Even biology has edge cases.

Dr. Phil Metzger @DrPhiltill · Feb 25
Replying to @DrPhiltill @VinnyChirayil and 2 others
8/ I mentioned archaeopteryx yesterday. Is it a bird or a non-bird reptile? It is hard to draw any sharp boundaries in nature. Sharpness is not what makes a taxonomy useful.

Well said, and I agree with all those points. We're going to talk about "Planet Nine," the so-called "true ninth planet" that Brown was talking about.

Planet “Nine” - Another Planet Other Than Pluto?

Following the media denying Pluto as a planet, is there really another planet lurking beyond Neptune or the Kuiper Belt? Mike Brown called that hypothetical planet “Planet Nine” or “Planet 9…” or more appropriately… I call it Planet X. Is that really an appropriate name? If such a planet exists, does it make gravitational changes to Neptune? Pluto is way too small to have pulled off Uranus and Neptune off course.

American astronomer Percival Lowell discovered that the orbits of ice giants Uranus and Neptune changed slightly, and decided that those changes were caused by another planet. He called it Planet X.

Artist’s impression of the hypothetical Planet X.

In November 12, 1916, Lowell died before he even found Planet X, leaving his work unfinished. He is buried under Mars Hill near his observatory.

But that didn't make astronomers give up! 14 years after Lowell's death, at Lowell Observatory, Clyde Tombaugh compared two photographs of the sky. One was the first image of a tiny speck, and when he compared the new photograph of the same location, the speck had actually moved slightly. That moving speck was actually Pluto, and it was once thought to be bigger than Earth!

OK, back to Planet X. Is Planet Nine an appropriate name? I don't think so *(see page 44, where Dr. Metzger says that Planet Nine is an inappropriate name for a large planet).*

Planet Nine does not sound like an appropriate name for this hypothetical planet. If it exists at the Kuiper Belt, it is unlikely that it will clear its orbit. So if it cannot be called Planet Nine, then I guess we shall stick with Planet X. What would you call it other than Planet X or Planet Nine?

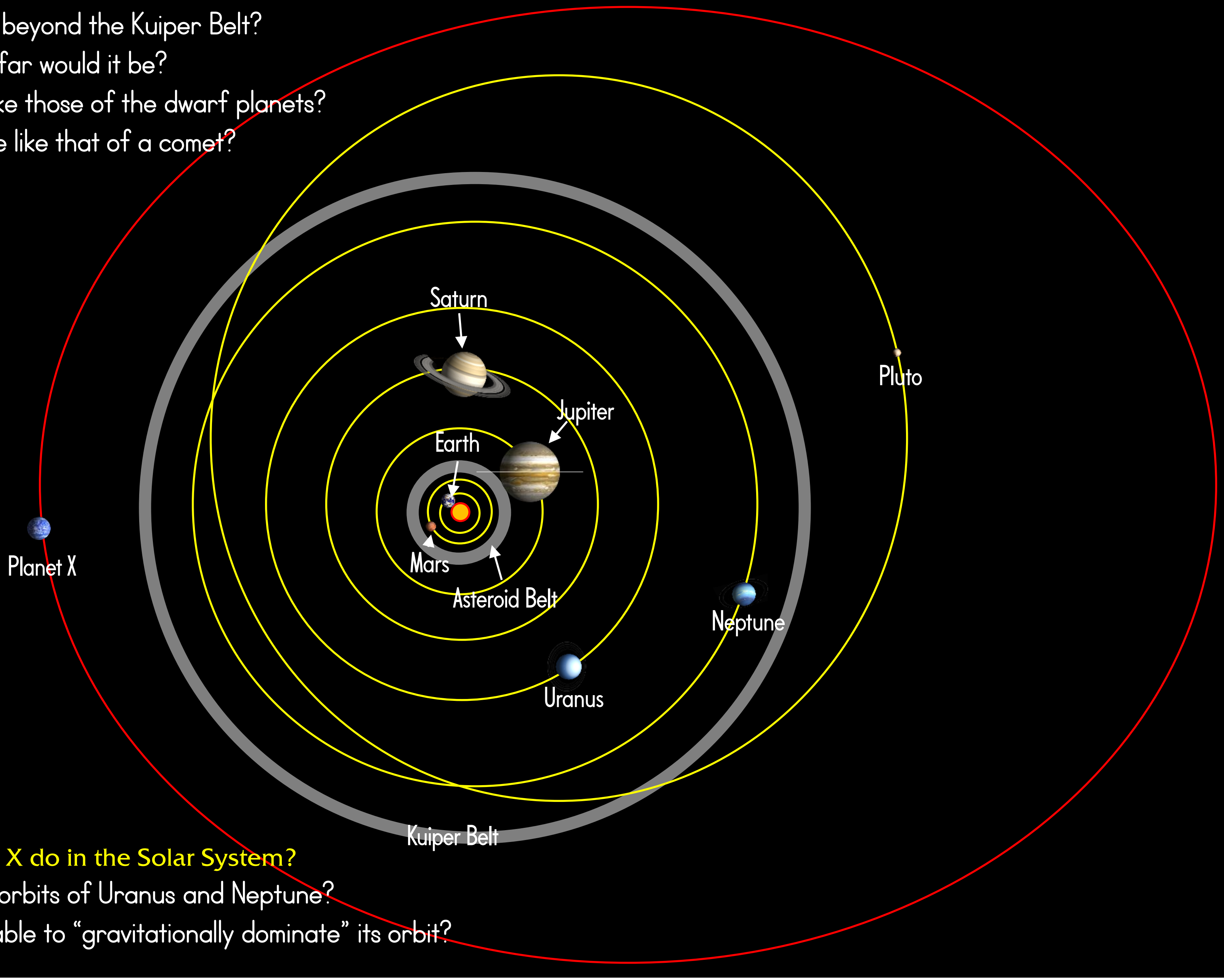
If Planet X exists, where could it be located at?

Would it be located beyond the Kuiper Belt?

If it does exist, how far would it be?

Would its orbit be like those of the dwarf planets?

Or would its orbit be like that of a comet?

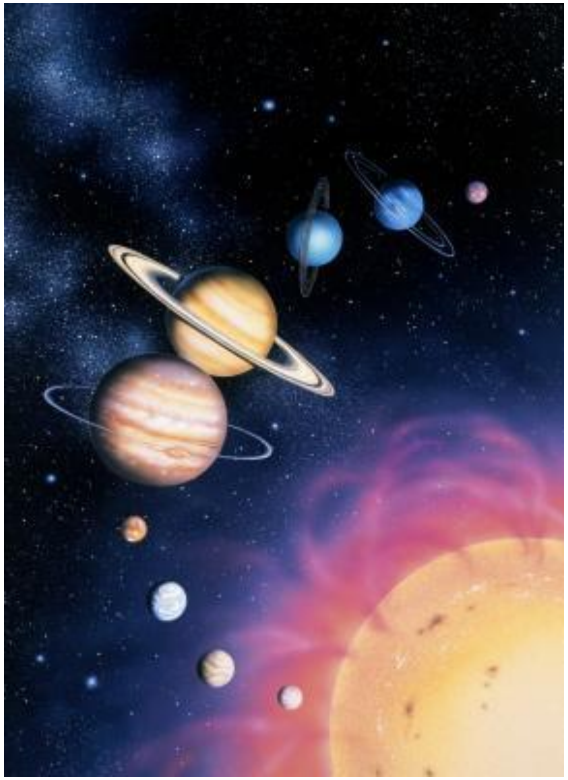


What would Planet X do in the Solar System?

Would it affect the orbits of Uranus and Neptune?

Would Planet X be able to “gravitationally dominate” its orbit?

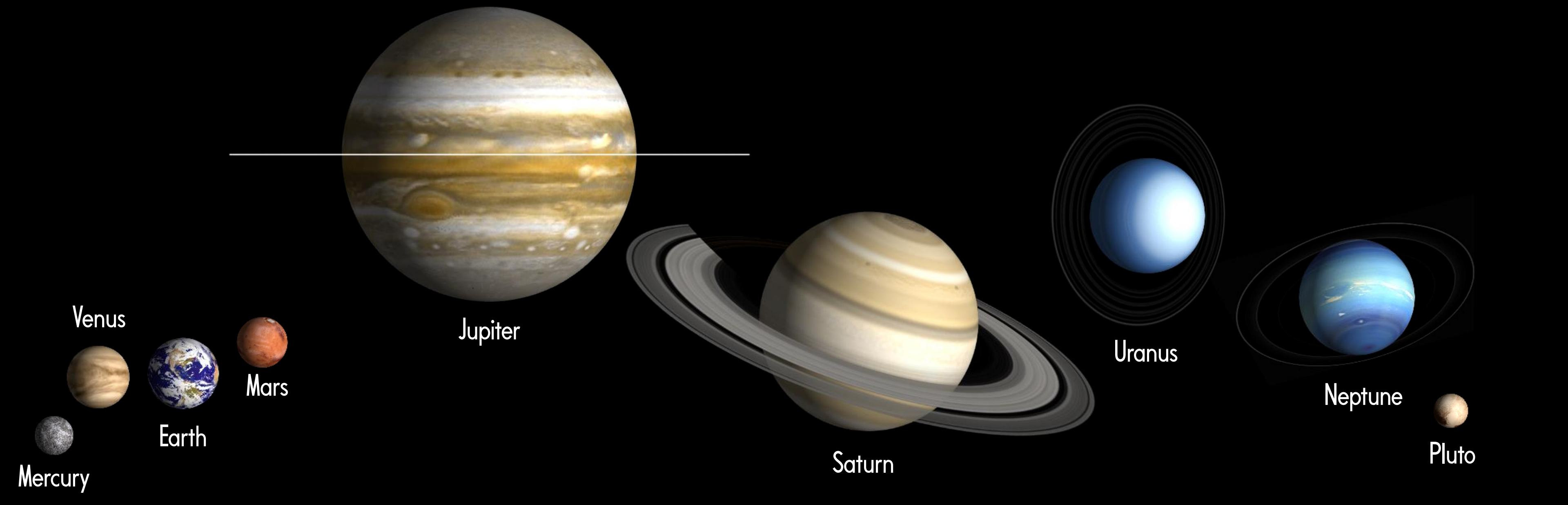
A Better Suggestion And Some Of My Advice



An artistic impression of the nine largest planets orbiting the Sun from Mercury to Pluto.

Alright, here's a better suggestion. The definition of a planet must be the geophysical planet definition and not the one the IAU uses today because it is really flawed. Limiting the number of planets to just 8 planets for elementary school kids does not sound great, it's like limiting the number of countries, states, rivers, species, elements, mountains, and so on to just eight of them. Kirby Runyon suggested that the nine planets shall be called "classical planets" as those planets are the most famous ones. I call those the nine largest planets orbiting the Sun.

Dwarf planets will be a subclass of planets that are tiny compared to terrestrial planets. In my classification, Pluto is an ice dwarf (an icy dwarf planet) since its surface is made mostly of ice.



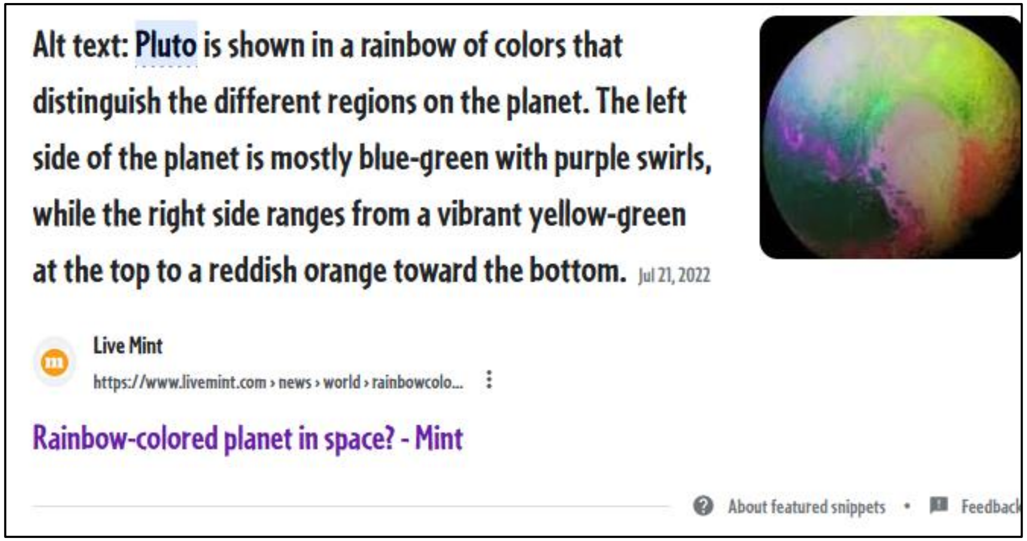
My montage of the nine “classical planets” as Kirby Runyon suggested (sizes not to scale)

For those who are elementary school kids, you may have learned about those nine planets, but in your montage or poster, you can add as many planets as you want (e.g. Ceres, Eris, Makemake, Haumea), and there are actually a lot of planets in our Solar System waiting to be discovered. You can also add asteroids and comets and even include the moons of the planets if you wish.

And to solve the misunderstanding after the revision that the IAU did in August 24, 2006. What they did in their definition of a planet left a huge hole in scientific studies.

So like what I've said before, For the media to understand, it's not that Pluto is no longer a planet, it's just that the IAU no longer considers it a planet.

Some newspaper articles still say that Pluto is a planet! Here's an article from the Indian newspaper Mint where they still call Pluto a planet. It features an image of Pluto in beautiful rainbow colours!



Alt text: Pluto is shown in a rainbow of colors that distinguish the different regions on the planet. The left side of the planet is mostly blue-green with purple swirls, while the right side ranges from a vibrant yellow-green at the top to a reddish orange toward the bottom. Jul 21, 2022

Live Mint
https://www.livemint.com › news › world › rainbowcolo...

Rainbow-colored planet in space? - Mint

Source: https://www.livemint.com/news/world/rainbowcolored-planet-in-space-11658382472812.html

And some advice for those who disagree with the IAU's planet definition, including myself:

If you don't want to follow the IAU's current planet definition and still consider Pluto a planet, well, here's some good news — you don't have to use that definition at all and you don't have to follow all the criteria! Well, except for the fact that a planet has to be round.

It's safe to say that Pluto is still a planet, not just to everyone's hearts, but in actual planetary science.

And for those who don't consider Pluto a planet and follow the IAU's definition of a planet, well, maybe you can just put the eight of the nine largest planets in your stamps, and I respect your opinion..

But all hope is not lost for the media to reconsider Pluto as a planet again!

My Opinions

Honestly, the fact that the media does not consider Pluto as a planet pisses me off because they're spreading bad science to little kids and students and misinforming the media. To be real, they're not bad people, but they're definitely just wrong.

The fact that I saw people protesting in some videos for Pluto's planetary rights makes science sound like politics.

And also, the IAU and those who denounce Pluto as a planet seem to be overacting just because they saw small planets similar to Pluto.

End!

State Your Opinions - Answer These Questions - Ask Some Planetary Scientists!

As you read this presentation, you may feel like answering those questions! There is no right or wrong answer for them. What are your thoughts? You can also ask planetary scientists those questions.
If you're a planetary scientist, you can also answer the questions too!

1. Should the media reconsider Pluto a planet again? Why or why not?

2. How would you feel if the media considers all the dwarf planets to be planets?

3. Mike Brown discovered dwarf planet Eris and thought of “demoting” Pluto after this. Whose fault is it?

4. If you were to change the definition of a planet, what should be the criteria?

5. What do you think when you hear the word “dwarf planets” and people don’t consider them as planets but consider dwarf stars as stars?

6. Which is better? The geophysical planet definition (GPD) or the IAU planet definition (IPD)?

7. It is thought that Pluto was once a moon of Neptune. Is that true?

8. If you want to classify a dwarf planet like Pluto based on its material, how would you call it?

9. How many planets in the Solar System do you want to add in your stamp collection?

10. Should children memorise big numbers of planets in the Solar System or not? Why?

The End!

Thank you!

Credits

Research by Jack Mitch Culberson

Uses information from Alan Stern, Cronodon, Laurel Kornfeld, Phil Metzger, NASA, and many more!

References: NASA, Microsoft Encarta, Alan Stern, Cronodon, Laurel Kornfeld, Phil Metzger, etc.

Many thanks to those people who made and took those images featured!

Note: There's still more to come!